GHD

Comments on Ipswich Flood Study Rationalisation Project, Phase 3 – Monte Carlo Analysis

In the introduction, the scope of the investigation should be summarised to highlight the limited number of runs being undertaken due largely to the nature of the hydrologic model. Namely, the RAFTS programme does not lend itself to automation of multiple runs necessary for a detailed Monte Carlo analysis, and therefore, it is an expensive exercise to undertake a more thorough analysis. Also, there has been some subjectivity about the RAFTS model results from earlier studies by others, and at this stage, this study serves a purpose by exploring the likely range in peak flow rate estimates for the 100 year ARI event, and other local government authorities are currently using the model. Given this background, it would not be prudent to switch to a more efficient modelling platform at this stage.

The study only uses CRC-FORGE data for storm durations of 24, 30, 36, 48, and 72 hours. The report should still acknowledge that durations for sub-daily durations can be estimated according to the procedure described in Australian Rainfall and Runoff (1999) based on Intensity Frequency Duration (IFD) datasets contained in that document. However, for the purposes of this study, sub-daily events were not considered.

Also, the report should possibly acknowledge that the Department of Natural Resources and Mines (DNRM) have released a computer programme to estimate IFDs using the CRC-Forge dataset. This programme estimates IFDs from 1 in 5 to 1 in 2,000 Annual Exceedance Probability (AEP) events for durations ranging from 1 hour to 120 hours. However, this programme was not available at the time of commissioning. The results from DNRM's programme will be nearly identical to the rainfall totals in this study.

In section 5.2.2 (Post Dam Conditions), the second dot point refers to "convert the sampled starting storage volumes ...", an explanation of what is meant by sampling in this instance would be helpful.

In Section 6.1 (Storm Duration), a 3 parameter generalised Pareto Distribution was adopted, and the report acknowledged this may not hold true for south-east Queensland. Rahman and Carroll have prepared a paper where a gamma distribution is employed and may be more suitable. Some commentary on Rahman and Carroll's work may be appropriate for completeness (a copy of this paper is attached).

Section 6.3 (Storm Temporal Distribution), the assumption of 50% probability of occurrence for the AVM patterns is appropriate. Perhaps the basis for this assumption could be expanded slightly, as the objective of deriving the AVM patterns during the revision of the Generalised Tropical Storm Method (GTSM) was to achieve AEP neutrality (Green et al, 2004), a copy of this paper is attached. Assuming 50% probability of occurrence with the ARR temporal patterns may not be sound.

Section 6.5 (Dam Starting Levels) indicates that the earlier SKM study used starting dam volumes of 50%, 75%, and 100% and these have been explored as part of this study. A nominal rectangular distribution has been employed. For completeness, the water level AEP distribution based on long-term daily dam behaviour simulations for the dams should be reviewed and compared. DNRM are likely to have such estimates, perhaps the distribution based on water levels at 1st December may be appropriate. The report also suggests the actual distribution of storage levels could be analysed to allow the assumed distribution to be refined (p44).

Ipswich Rivers Improvement Trust
August 2000

Ipswich Rivers Flood Studies
Phase One and Phase Two

Rev 0

Sinclair Knight Merz Pty. Ltd.
A.C.N. 001 024 095
49 Annand Street
PO Box 839
Toowoomba QLD
Australia 4350
Telephone: +61 7 4639 8400
Facsimile: +61 7 4639 8490
http://www.skm.com.au

SINCLAIR KNIGHT MERZ

Contents

Document History and Status

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
1	0	IRIT	11	18/8/00	MDS	SAA
1	0	SKM	2	18/8/00	MDS	SAA

Printed:	10 September 1997 1:33 PM
Last Saved:	18 August 2000 4:07 PM
File Name:	\\SKM-TOBA1\VOL1\DATA\REED\re04390\cor99_02.22\rp424mfinal.doc
Project Manager:	SAA
Name of Organisation:	Ipswich Rivers Improvement Trust
Name of Project:	Ipswich Rivers Flood Studies Phase One and Phase Two
Name of Document:	
Document Version:	Rev 0
Project Number:	RE04390

Figures

Tables

Acknowledgments

Sinclair Knight Merz would like to thank the following organisations for their assistance throughout this study.

Department of Natural Resources (DNR)
Bureau of Meterology (BOM)
South East Queensland Water Board (SEQWB)
Brisbane City Council (BCC)
Ipswich City Council (ICC)

In particular, we would like to thank Terry Malone (BOM), John Ruffini (DNR), Garry Grant (SEQWB) and Ken Morris (BCC) for without their help and supply of information our task would have been much more difficult. We would also like to thank the ICC Asset Management Group for there assistance with the provision of GIS data and the preparation of some of the flood mapping in the Flood Study Atlas.

Executive Summary

Sinclair Knight Merz was commissioned in 1998 by the Ipswich Rivers Improvement Trust to undertake flood studies of the major rivers and creeks in the Ipswich City area.

The primary objective of the study was to establish technically based design flood levels for the major waterways within the currently urbanised areas of Ipswich City. These levels were determined for the following river and stream networks:

- Bremer River (from confluence with Warrill Creek to the Brisbane River)
- Bremer River Tributaries
  - Bundamba Creek
  - Warrill Creek
  - Purga Creek
  - Deebing Creek
  - Ironpot Creek
  - Mihi Creek
  - Sandy Creek (Chuwar)
- Brisbane River (from confluence with Woogaroo Creek to the confluence with Kholo Creek)
- Brisbane River Tributaries
  - Six Mile Creek
  - Goodna Creek
  - Woogaroo Creek
  - Sandy Creek (Camira).

The modelling and investigation undertaken in this study will form the basis of future assessment of the impacts of development on flooding, the assessment of flood inundation and flood damage, the development of flood mitigation strategies for existing flood prone properties and the determination of an adopted design flood standard for new development and overall floodplain management strategies including policy decisions.

The study involved the collection and analysis of available rainfall, streamflow, topographic and hydrographic data. Using this data a hydrologic and hydraulic model was developed, calibrated and tested using five historical flood events. These floods were:

- January 1974
- June 1983
- Late April 1989
- December 1991
- May 1996

The hydrologic modelling has been carried out using the RAFTS hydrologic model. The model converts rainfall to runoff after considering catchment storage effects and losses.

The MIKE11 hydrodynamic model was selected for the hydraulic analysis.

Calibration of the hydrologic and hydraulic models was carried out in parallel to ensure the river storage in the two models was consistent. Parameters within the hydrologic model were adjusted until a good match between continuous historical stream flow records and predicted streamflows were achieved. These flows were then used in the hydraulic model and calibration was conducted until predicted flood levels provided a good match between continuous historical flood level data and peak flood levels. The discharge hydrographs routed through MIKE11 were then compared to the discharge hydrographs produced by RAFTS. This process was repeated until the peak discharges of the hydrographs produced by each model were consistent to within 10%.

The MIKE11 hydraulic model was calibrated to recorded historical flood levels primarily through variation of Manning's n roughness parameters along the river.

Good calibration of both the hydrologic and hydraulic models have been obtained. These results were achieved on the basis of:

- maintaining realistic rainfall loss rates over the entire catchment
- maintaining realistic waterway and floodplain roughness parameters representative of the current floodplain configuration and
- obtaining a satisfactory hydraulic performance of the major structures.

An analysis of design storm events was then performed to establish design flood characteristics in the waterways using the calibrated hydrologic RAFTS model and the MIKE11 hydraulic model. A range of varying average recurrence intervals from 2 year ARI through to Probable Maximum Precipitation were analysed.

The hydrologic analysis was performed for existing catchment conditions to determine inflow hydrographs for the calculation of design flood profiles for the various waterways. These design events were analysed assuming simplified operations of Wivenhoe and Somerset Dams as RAFTS cannot model the complex operations associated with these dams. The design flood profiles have been prepared using MIKE11. The tabulated results from these profiles provide peak flood levels and discharges at each cross section within the extent of the hydraulic model.

Flood maps for the modelled section of the Ipswich floodplain were generated using results from the MIKE11 hydraulic model for the Ultimate Catchments Conditions case. The digital elevation model developed for Ipswich City Council was used in conjunction with the MIKE11 results to produce depth/inundation plots over the study area. Depth/inundation plots were generated for the 1 in 20 year and 1 in 100 year average Recurrence Interval design events.

A number of flood mitigation measures were identified which included:

- changes to Wivenhoe and Somerset Dam operations
- detention basins
- levee schemes.

Of these options levee schemes were identified as the mitigation option which would be most effective on the Ipswich Floodplain.

A preliminary assessment identified nine possible levee scheme locations. Each of the levee schemes should only be considered as a potential location based on preliminary assessment. If any of the levees are to be considered further, a detailed analysis should be undertaken investigating, hydraulics, environmental, financial and social issues.

114

1. Introduction

The Ipswich Rivers Floodplain Management Study - is a major initiative of the Ipswich Rivers Improvement Trust to establish a suitable Floodplain Management Plan for rivers and creeks situated within the Ipswich City area. This Draft Final Report combines Phase's 1 and 2 of the Ipswich Rivers Flood Plain Management Study.

The primary objective of this study was to establish design flood levels for the following river networks within Ipswich City:

- Bremer River and tributaries (Bundamba Ck, Warrill Ck, Purga Ck, Deebing Ck, Ironpot Ck, Mihi Ck and Sandy Ck (Chuwar))
- Brisbane River (from the confluence of Woogaroo Ck to the confluence with Kholo Ck)
- Brisbane River Tributaries (Six Mile Ck, Goodna Ck, Woogaroo Ck and Sandy Ck (Camira)).

The Calibration Report was the first of a series of progress reports. It documented the analyses undertaken to validate the hydrological model (RAFTS) of the Brisbane River Catchment and its relevant tributaries and a hydraulic model (MIKE11) of the Ipswich City reach of Brisbane River and its relevant tributaries as listed above.

The hydrological and hydraulic models developed for the Brisbane River Flood Study (BCC 1998) were used as a basis for this study and these models were refined and extended in order to meet the requirements of the Ipswich Rivers Floodplain Management Study.

The Draft Design Events Report was the second in a series of reports which estimates flood levels and discharges throughout the Phase 1 and Phase 2 creeks within the confines of Ipswich City. The calibrated Ipswich Rivers Flood Studies hydrological and hydraulic models were used for the assessment.

The Ultimate Catchments Events Report was the third in a series of reports. This report investigated the effects that future urbanisation will have on flood levels, discharges and velocities. Note that this report does not look at filling development on the floodplain, but looks at the changes in runoff due to change in land use.

The final phase of the studies was the flood mapping and flood mitigation phase of the studies. That report was the fourth in the series of reports and investigated the extent of flooding for the 100 year and 20 year ARI flood events. The report also identified possible flood mitigation measures that could be considered to reduce flooding within the City of Ipswich.

Following review of these four reports by the Ipswich Rivers Improvement Trust, this Final Draft Report has been compiled, collating all of the findings from the previous reports. To accompany this report, a flood study atlas has also been prepared. This atlas contains plans illustrating historic and design flood characteristics for the modelled sections of the floodplains of Ipswich City.

2. Catchment Description

The extent of the Brisbane Valley catchment is shown in **Figure 2.1: Locality Plan.** It covers an area of 13 570 square kilometres and is bounded to the west by the Great Dividing Range and by a number of smaller coastal ranges to the east and north. Most of the catchment is comprised of forest and grazing land, with the exception of the Brisbane - Ipswich metropolitan areas and numerous small rural townships.

Cooyar Creek, Emu Creek and Cressbrook Creek are the main tributaries of the upper Brisbane River and have headwaters in the Great Dividing Range. Cooyar Creek is the most northerly of the upper Brisbane River tributaries and tends to have the lowest annual rainfalls recorded within the catchment.

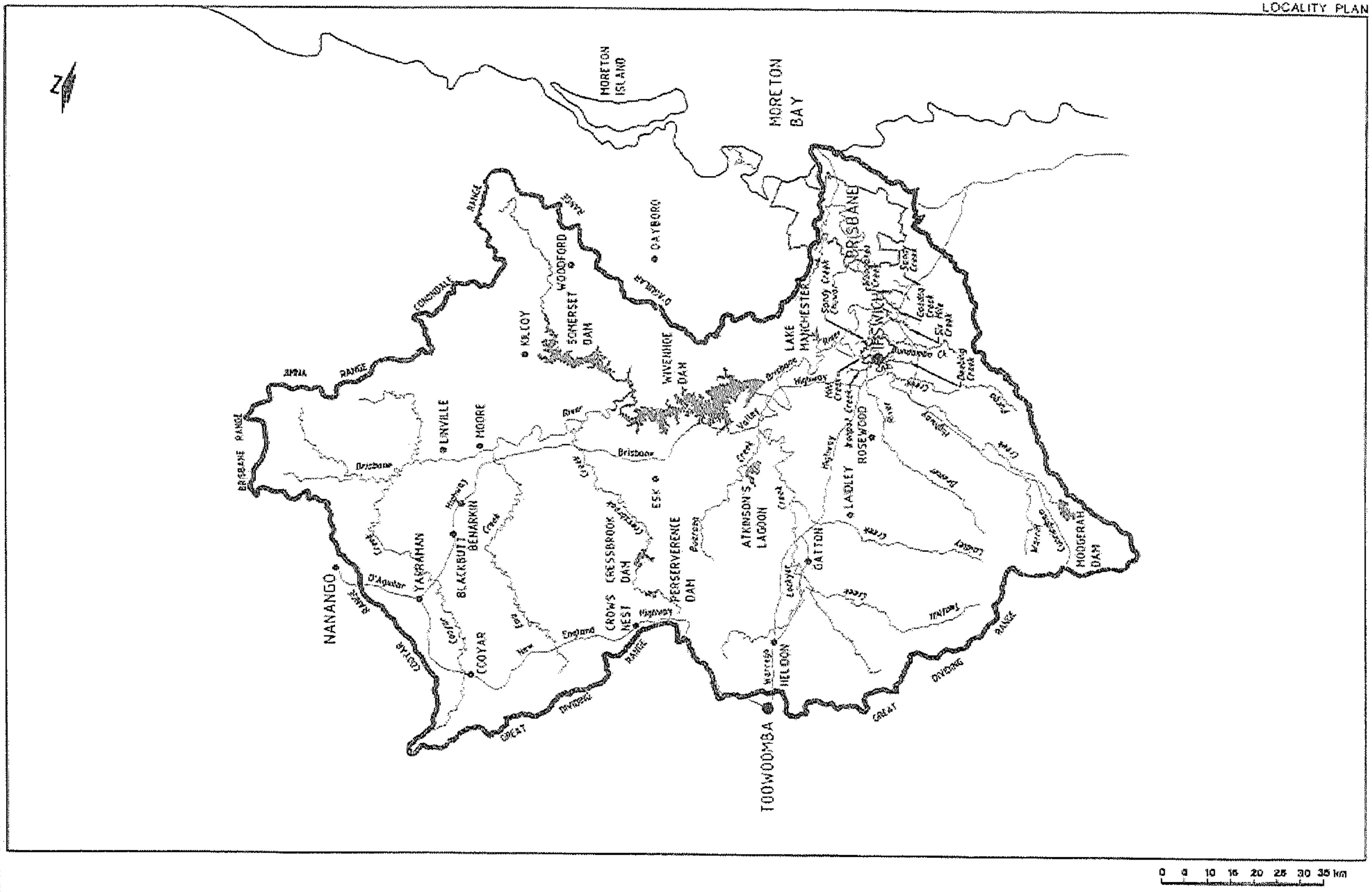
The Stanley River is the only major tributary of the Brisbane River that flows westwards and its source is the Conandale and D'Aguilar Ranges near the coast. This part of the Brisbane River catchment is relatively steep and receives the highest rainfall.

Lockyer Creek is the largest tributary of the Brisbane River in terms of catchment size, with a total area of 2 600 square kilometres. The lower floodplains of the Lockyer Valley are used for intensive agriculture, including vegetables and small crops. The hilly upper parts of the catchment to the south and west are mainly forest.

The Bremer River occupies the south west corner of the Brisbane Valley and has its headwaters in the Little Liverpool Range. Its catchment is generally hilly and lightly forested with a catchment area of approximately 1500 km^2. A major tributary of the Bremer River is Warrill Creek which accounts for more than two thirds the catchment area. Within the boundaries of the Bremer River Catchment lies Moogerah Dam, which supplies irrigation water to local rural areas, cooling water to Swanbank Power Station and urban water to some smaller towns within Ipswich City. Other major tributaries of the Bremer River include Purga Creek, Ironpot Creek, Deebing Creek, Mihi Creek, Sandy Creek (Chuwar) and Bundamba Creek. The lower reaches of the Bremer River flow through the City of Ipswich.

Bundamba Creek is a major contributor to the Bremer River and has a catchment area of approximately 110 km^2. Bundamba Creek contains significant areas of development in its lower reaches, however the upper reaches are predominantly rural. There are also pockets of open cut mining situated within the catchment.

FIGURE 2.1
IPSWICH RIVERS FLOOD STUDY
LOCALITY PLAN



FILE NAME: 0432C-11 DISC N°: 11/VRALON JOB N°: T016390 DATE: 3-2-99
PLOT SCALE: 1:750(A3)

Warrill Creek is a major tributary of the Bremer River with a catchment area of approximately 1 150 km^2. Warrill Creek Catchment makes up two thirds of the Bremer River Catchment and is predominantly rural with a number of small townships such as Aratula, Harrisville and Kalbar located within the catchment Boundary. Lake Moogerah is also located within the Warrill Creek Catchment.

Purga Creek is a tributary of Warrill Creek and has a total catchment area of approximately 220 km^2. The Purga Creek Catchment contains no urban areas and is predominantly grassland and open woodland.

Deebing Creek is a tributary of the Bremer River and has a total catchment area of approximately 26 km^2. The Deebing Creek Catchment is predominantly rural with a number of urban areas such as Churchill and Winston Glades contained within the catchment area. Deebing Creek has two major tributaries, Reedy Creek and Small Creek.

Ironpot Creek is a tributary of the Bremer River and has a total catchment area of approximately 17 km^2. The Ironpot Creek Catchment is predominantly rural with a number of urban areas such as Brassall and Blacksoil contained within the catchment area.

Mihi Creek is a tributary of the Bremer River and has a total catchment area of approximately 7 km^2. The Mihi Creek Catchment is predominantly rural with a number of urban areas such as Brassall and Emerald Hill contained within the catchment area.

Sandy Creek (Chuwar) is a tributary of the Bremer River and has a total catchment area of approximately 9 km^2. The Sandy Creek Catchment (Chuwar) is predominantly rural with a number of urban areas such as Chuwar and Tivoli contained within the catchment area.

Six Mile Creek is a tributary of the Brisbane River and is predominantly urban in the lower reaches and generally hilly and lightly forested in the upper areas. Six Mile Creek has an approximate catchment area of 31 km^2 and runs through the suburbs of New Chum and Riverview.

Goodna Creek is a tributary of the Brisbane River and is predominantly urban in the lower reaches and generally hilly and lightly forested in the upper areas. Goodna Creek runs through the suburbs of Redbank and Collingwood Park and has an approximate catchment area of 21 km^2.

Sandy Creek (Camira) is a tributary of the Brisbane River and is predominantly urban in the lower reaches with undulating lightly forested hills in the upper areas. Sandy Creek has an approximate catchment area of 44 km^2 and runs through the suburbs of Camira, Carole Park and Wacol.

Woogaroo Creek is a tributary of the Brisbane River and is predominantly urban in the lower reaches with undulating lightly forested hills in the upper areas. Woogaroo Creek runs through the suburbs of Goodna, Galles and Bellbird Park and has an approximate catchment area of 65 km^2.

The Brisbane River, Bremer River and their major tributaries are regulated by several dams and reservoirs. A list of major dam structures is given in **Table 2.1: Major Dams in the Brisbane Valley**. The largest storages are associated with Somerset Dam and Wivenhoe Dam.

Table 2.1: Major Dams in the Brisbane Valley

Damsite	River/Creek	Year of Completion	Capacity at Full Supply Level (ML)
Wivenhoe	Brisbane	1985	1 150 000
Somerset	Stanley	1959	369 750
Cressbrook	Cressbrook	1982	78 300
Perseverance	Perseverance	1965	30 300
Atkinson	Buaraba	1970	31 300
Lake Manchester	Cabbage Tree	1916	25 700
Mt Crosby Weir	Brisbane	1901	2 590
Moogerah Dam	Reynolds	1961	92 500
Enoggera Creek	Enoggera	1866	4 500

Somerset Dam is a multi-purpose dam owned by the South East Queensland Water Board and operated by Brisbane City Council. It supplies water for Brisbane, Ipswich and adjacent shires, has a limited power generation capacity and is also used for recreation purposes. A major role of the dam is for flood mitigation and a temporary flood storage of 524 000 ML is available.

Wivenhoe Dam is the largest dam structure in the Brisbane Valley and commands about half of the total Brisbane River Catchment. It has a major effect on river hydrology due to its large flow regulation capacity. About 1 450 000 ML of flood storage is available at the dam.

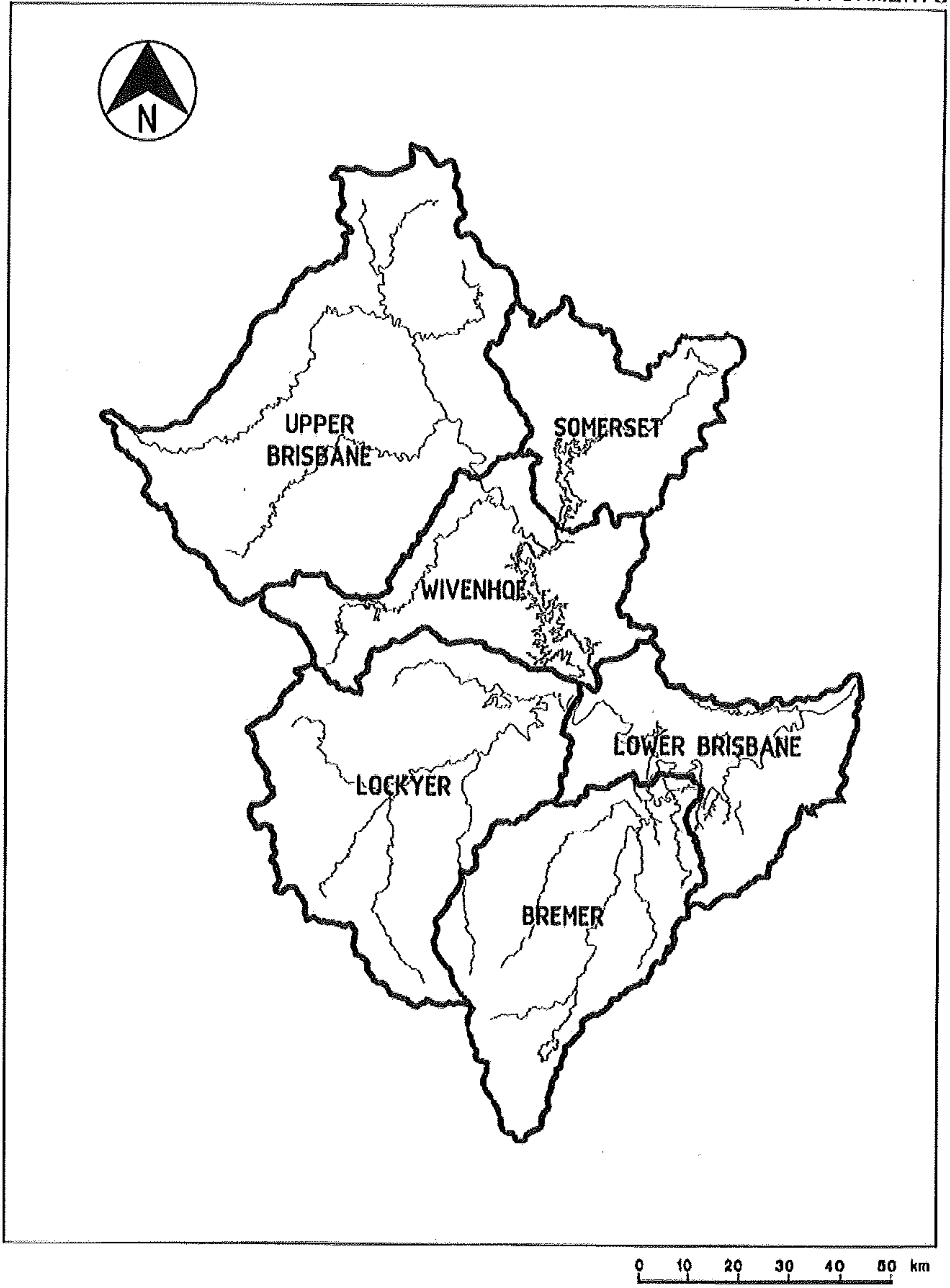
Moogerah Dam was not considered in detail for the Ipswich Rivers Flood Studies as the dam is located in the upper catchment and it has a relatively small storage of 92 500 ML. It was therefore considered that the flood mitigation effects of this storage would not be significant.

For the purpose of hydrologic modelling the Brisbane River catchment can be divided into six broad sub-catchments. The boundary of each sub-catchment defined as Upper Brisbane, Somerset, Wivenhoe, Lockyer, Bremer and Lower Brisbane, are shown in **Figure 2.2: Brisbane River Sub-catchments**

SINCLAIR KNIGHT MERZ

FIGURE 2.2

IPSWICH RIVERS FLOOD STUDY
BRISBANE RIVER SUB-CATCHMENTS



FILE NAME: 04350-02 DISK N°: U:\FWUD JOB N°: T004390 DATE: 2-3-95
PLOT SCALE: 1:1000(A4)

3. Available Data

3.1 Stream Gauges

Available Stream Gauges

Recorded flood hydrographs at key locations in the Brisbane and Bremer River systems are required for the purpose of hydrologic model calibration.

The network of stream gauges associated with the greater Brisbane River Catchment is shown in **Figure 3.1: Stream Gauge Locations** and detailed in **Table 3.1: Brisbane River Stream Gauge Summary.** Several stream gauges have historical records extending over a period of more than eighty years. The majority of stream recorders were installed during the post 1960 period. Some gauges have been decommissioned including Brisbane River at Middle Creek, Crossbrook Creek at Damsite (both due to dam construction) and Warrill Creek at Kalbar.

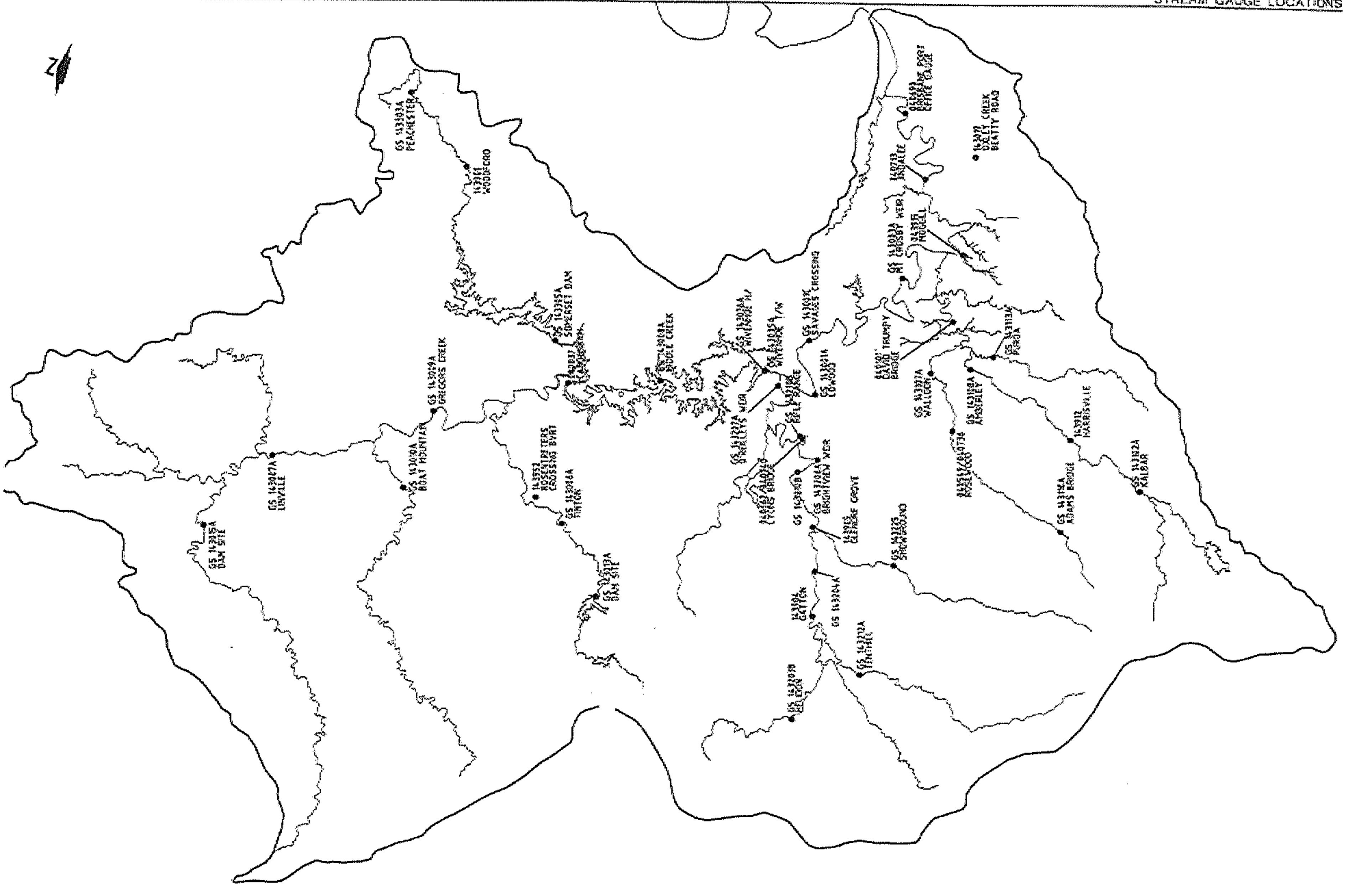
Several stream gauges are located in the upper tributaries of the Brisbane River system and command a relatively small fraction of the total catchment draining to the Cities of Brisbane and Ipswich. About ten gauges have drainage areas less than 5 percent of the total Brisbane Valley catchment and are of secondary importance in the RAFTS model calibration process.

The primary stream gauges used for model calibration purposes include:

- Brisbane River at Linville - includes Cooyar Creek and headwaters of Brisbane River.
- Brisbane River at Gregors Creek - downstream of Linville and includes streamflows from Emu Creek, Maronghi Creek and Ivory Creek.
- Brisbane River at Middle Creek - sited downstream of the Stanley River confluence and was closed in August 1982 due to the construction of Wivenhoe Dam. Records since 1959 includes the flow regulation effects of Somerset Dam.
- Brisbane River at Lowood - is sited downstream of the confluence of Brisbane River and Lockyer Creek.
- Brisbane River at Savages Crossing and Mt Crosby - are both long term streamgauge sites and are important in isolating flow travel times and channel routing effects along the mid-reach section of the Brisbane River (between the Lockyer Creek and Bremer River junctions).
- Brisbane River at Moggill, Jindalee and Post Office Gauge are downstream of the Bremer River and are located within the coverage of the Brisbane River MIKE11 model.

SINCLAIR KNIGHT MERZ

FIGURE 3.1
IPSWICH RIVERS FLOOD STUDY
STREAM GAUGE LOCATIONS



LEGEND

o STREAM GAUGE LOCATION

0 5 10 15 20 25 km

Table 3.1: Brisbane River Stream Gauge Summary

Number	Stream	Site	Record	% Catchment Area
Upper Brisbane River				
143015	Cooyar Creek	Damsite	1968 - date	7
143007	Brisbane River	Linville	1964 - date	15
143010	Emu Creek	Boat Mtn	1976 - date	7
143009	Brisbane River	Gregors Creek	1962 - date	29
143002	Brisbane River	Fulham Vale	1920 - 1965	29
Somerset and Wivenhoe				
143305	Stanley River	Somerset Dam	1935 - date	10
143008	Brisbane River	Middle Creek	1962 - 1982	49
143036	Brisbane River	Wivenhoe Dam	1986 - date	52
143901	Stanley River	Woodford	1918 date	2
143303	Stanley River	Peachester	1927 - date	1
143013	Cressbrook Creek	Damsite	1965 - 1981	2
143006	Tinton	Cressbrook Ck	1928 - 1980	3
143302	Stanley River	Silverton	1919 - 1968	10
Lockyer				
143203	Lockyer Creek	Helidon	1926 - date	3
143212	Tenthill Creek	Tenthill	1968 - date	3
143225	Laidley Creek	Showground	1984 - date	2
143210A	Lockyer Creek	Lyons Bridge	1909 - date	10
143210B	Lockyer Creek	Rifle Range	1988 - date	10
143907	Brisbane River	Lowood	1909 - date	77
143905	Lockyer Creek	Glenore Grove	1955 - date	16
143904	Lockyer Creek	Gatton	1929 - date	12
143204	Lockyer Creek	Wilsons Weir	1959 - 1982	12
143206	Brisbane River	Brightvew Weir	1953 - 1973	18
Bremer and Lower Brisbane				
143001	Brisbane River	Savages Cross	1909 - date	78
143003	Brisbane River	Mt Crosby	1900 - date	78
143110	Bremer River	Adams Bridge	1968 - date	1
143107	Bremer River	Walloon	1961 - date	5
143102	Warrill Creek	Kalbar	1912 - 1973	3
143108	Warrill Creek	Amberley	1961 - date	7
143113	Purga Creek	Loamside	1973 - date	2
143011	Bremer River	David Trumpy	1893 - date	14
143915	Brisbane River	Moggill	1965 - date	94
143982	Brisbane River	Jindalee	1974?	95
143919	Brisbane River	Port Office	1841 - date	100
143101	Warrill Creek	Mudtapilly	1914 - 1953	6

Note: % catchment area estimated as proportion of total Brisbane River Catchment (equal to 13 570 km²) upstream of the stream gauge.

- Lockyer Creek at Glenore Grove - accounts for about 85% of the Lockyer Creek catchment (which in turn is of the order of 20% of the total Brisbane River catchment).

- Lockyer Creek at Lyons Bridge and Rifle Range are sited near the Brisbane River. Gauge heights are subject to backwater effects associated with Brisbane River floodwaters.

- Warrill Creek at Amberley measures streamflows on this major tributary of the Bremer River catchment.

- Purga Creek at Loamside measures streamflows upstream of the Cunningham Highway and is a significant contributor to Warrill Creek.

- Bremer River at David Trumpy Bridge is located in the centre of Ipswich and gauge heights are affected by incidence of flooding within the Brisbane River. The Bremer River catchment contributes to about 15 percent of the total Brisbane River catchment area.

A series of telemetric alert gauges have been established within the catchment for flood warning purposes and are utilised by the Ipswich City Council, Department of Natural Resources and the Bureau of Meteorology. Most of these stream gauges have been installed in the last five years and are also shown in **Figure 3.1: Stream Gauge Locations.** A listing of selected gauges is given in **Table 3.2: Brisbane River Catchment Flood Alert Gauges.** The location of these gauges is illustrated on **Figure 3.2: Flood Alert Locations.**

Stream Gauge Rating Curves
Stage discharge curves are available at the majority of stream gauges and were supplied by the Hydrology Section, Bureau of Meteorology. These rating curves are presented in **Appendix A - Brisbane River Catchment Rating Curves.** All original rating curves were used in the RAFTS hydrological model except where identified in **Appendix A.**

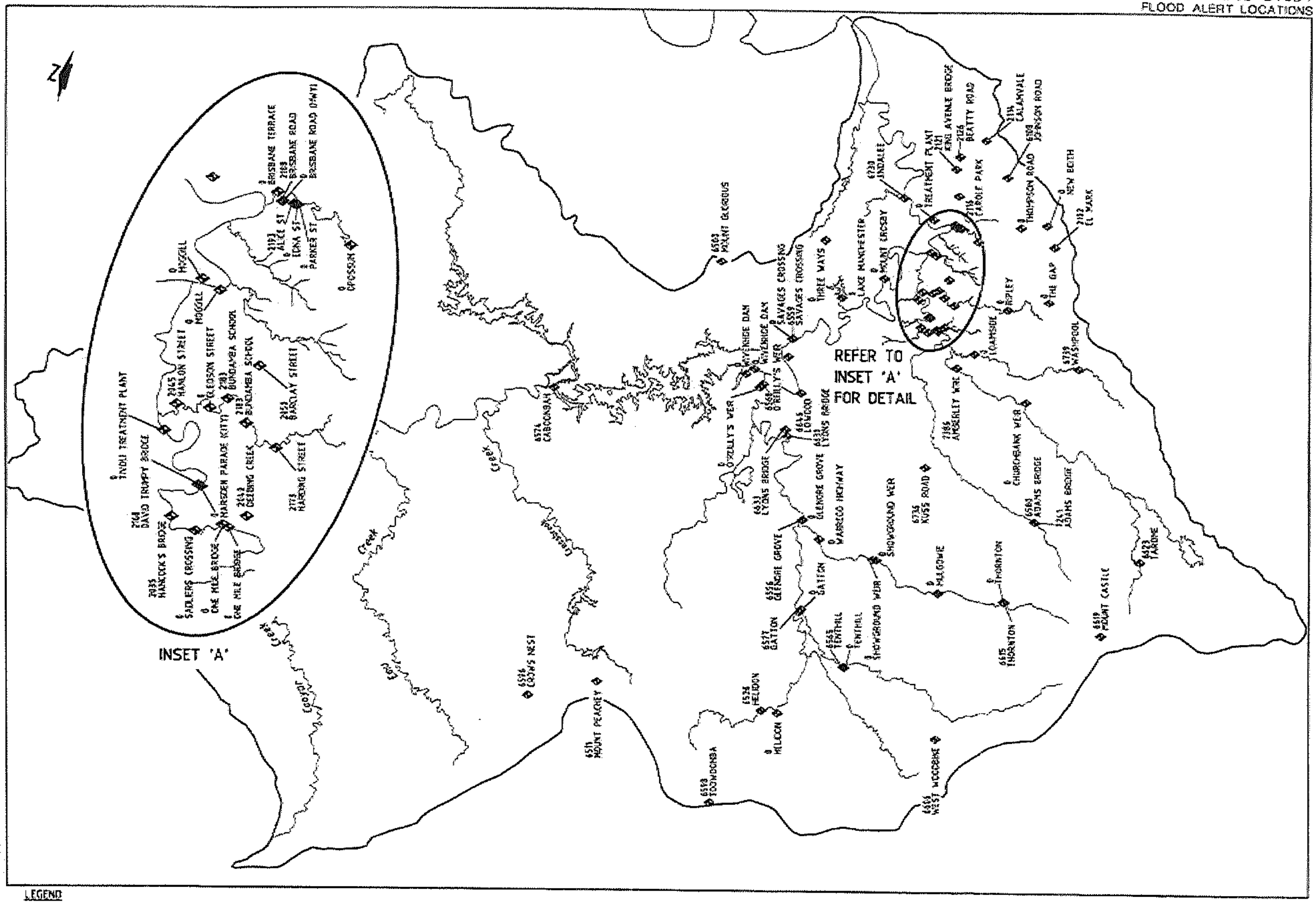
Somerset Dam and Wivenhoe Dam Discharges
Inflow and outflow hydrographs associated with Somerset Dam and Wivenhoe Dam for several floods were supplied by Surface Water Assessment, Department of Natural Resources. The inflows are synthetic hydrographs derived from historical lake level data and storage outflow records.

3.2 Rainfall Data

Daily rainfall data and representative pluviograph data is required to describe the areal and temporal distribution of rainfall associated with historical flood events.

FIGURE 3.2

IPSWICH RIVERS FLOOD STUDY
FLOOD ALERT LOCATIONS



LEGEND
◈ FLOOD ALERT LOCATIONS

FILE NAME: 24390-06 PLOT SCALE: 150(A3) DSK No: U.NPWID JOB No: TD84390 DATE: 3-2-99

Table 3.2: Brisbane River Catchment Flood Alert Gauges

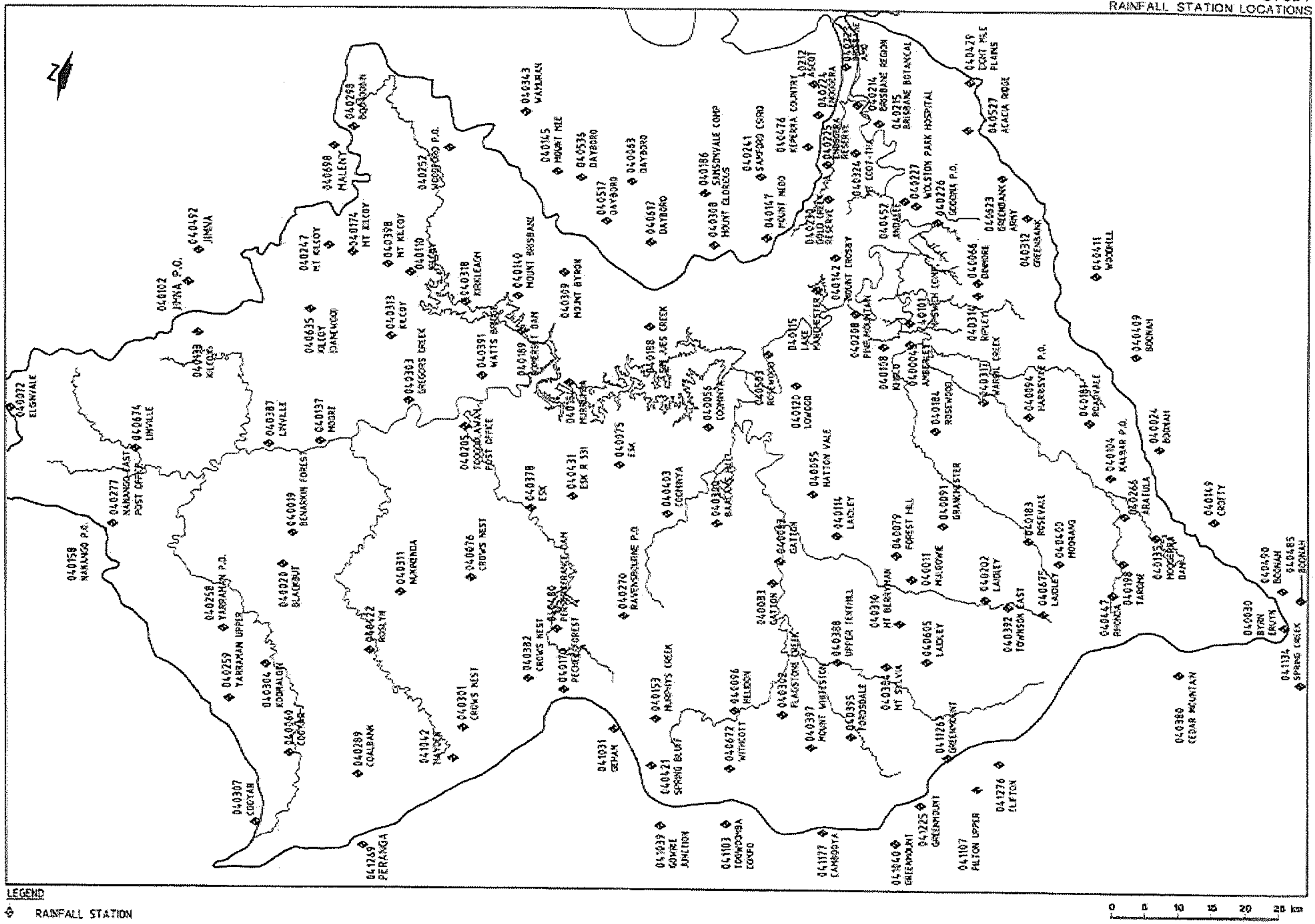
Alert Number	Stream	Site
Upper Brisbane		
6709	Brisbane River	Devon Hills
6515	Brisbane River	Gregors Creek
Somerset and Wivenhoe		
6554	Cressbrook Creek	Rosentreters Bridge
6575	Brisbane River	Cabconbah
Lockyer		
6634	Lockyer Creek	Lyon
21010	Laidley Creek	Thornton
7078	Laidley Creek	Mulgowie
7167	Laidley Creek	Warrego Highway
Bremer and Lower Brisbane		
21026	Western Creek	Kuss Road
7020	Bremer River	Rosewood
??????	Bremer River	One Mile Bridge
??????	Bremer River	Sadliers Crossing
??????	Bremer River	Hancock Bridge
??????	Bremer River	Marsden Parade (City Gauge)
??????	Bremer River	Tivoli Treatment Works
??????	Bundamba Creek	Ripley
??????	Bundamba Creek	Harding St
??????	Bundamba Creek	Blackstone Rd
??????	Bundamba Creek	Highway
??????	Bundamba Creek	Gledson St
6572	Warrill Creek	Harrisville
6740	Purga Creek	Washpool
??????	Woogaroo Ck	Parker St
??????	Woogaroo Ck	Edna St
??????	Woogaroo Ck	Highway
??????	Woogaroo Ck	Brisbane Tce

Note: This table excludes alert stations located in Brisbane metropolitan area.

A total of about 60 rainfall stations were applied in this flood study and the coverage of these stations within and adjacent to the catchment is shown in **Figure 3.3: Rainfall Station Locations.** A listing of stations is compiled in **Appendix B.**

SINCLAIR KNIGHT MERZ

FIGURE 3.3
IPSWICH RIVERS FLOOD STUDY
RAINFALL STATION LOCATIONS

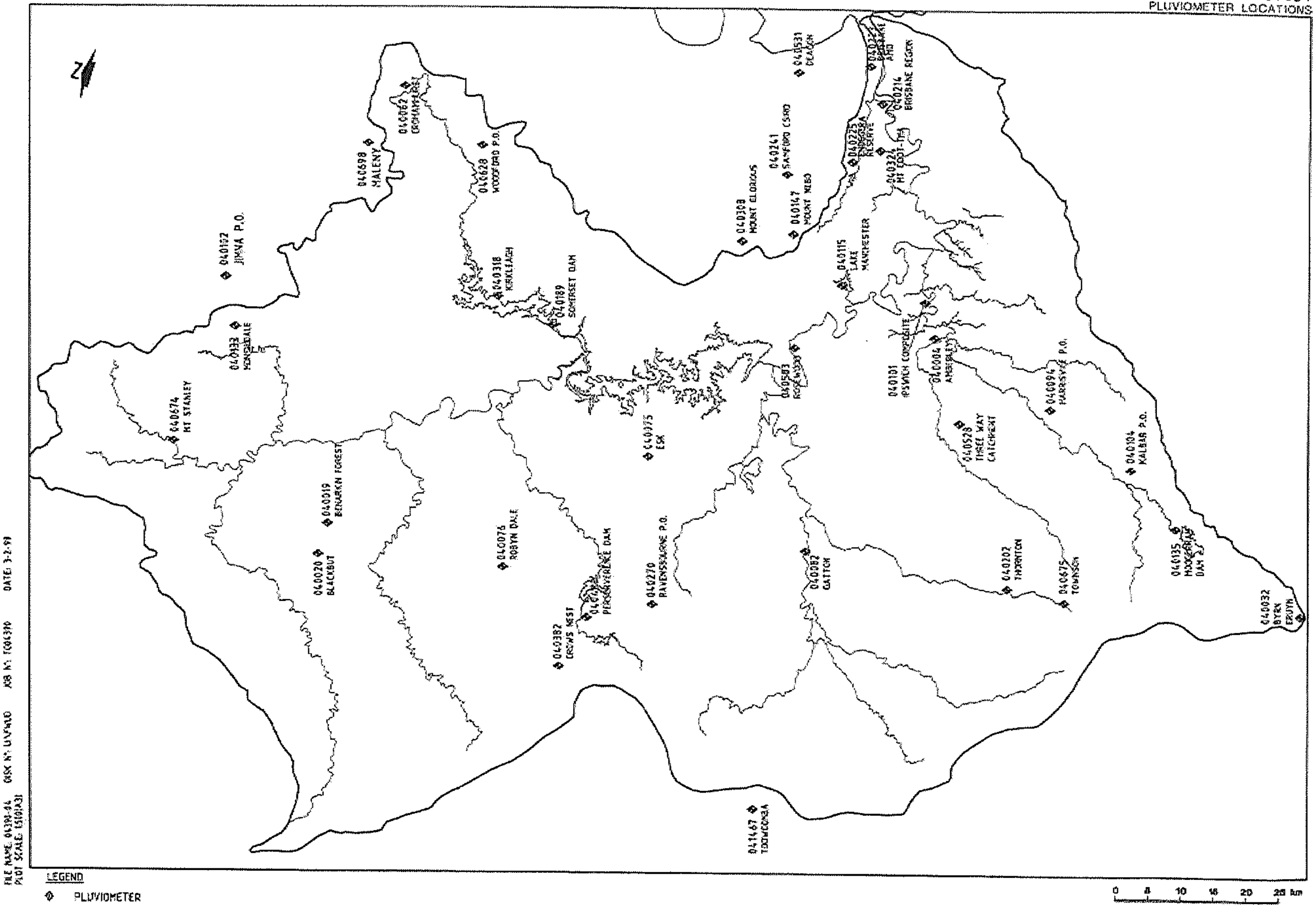


FILE NAME: 6439I.05 DISK Nº: UAFWLD JOB Nº: TOO1390 DATE: 3-2-99
PLOT SCALE: 1510(AD)

Pluviometers, which record the temporal variation of rainfall during a storm, are distributed within the catchment as indicated on **Figure 3.4: Pluviometer Locations.** These recorders are owned and operated by various authorities including the Bureau of Meteorology, Department of Natural Resources, Brisbane City Council, Toowoomba City Council and CSIRO. Several pluviometers have been recently installed as part of a flood alert system for the Brisbane River. A listing of pluviometers is also compiled in **Appendix B.**

SINCLAIR KNIGHT MERZ

FIGURE 3.4
IPSWICH RIVERS FLOOD STUDY
PLUVIOMETER LOCATIONS



4. Review of Previous Studies

4.1 Overview

Brisbane River

The most significant past study of the Brisbane River Catchment was undertaken by the Department of Primary Industries (now Department of Natural Resources or DNR) for the South East Queensland Water Board during the period 1991 to 1994. The study was associated primarily with Somerset Dam and Wivenhoe Dam and included a revision of design floods, the development of runoff routing and hydraulic models and a management system for the flood operation of the dams.

Another significant past study for the Brisbane River Catchment that has been completed is the Bureau of Meteorology (BOM) URBS Flood Forecasting Model. This model was based on DNR model and uses a real time data collection system linked to the URBS model for Flood Forecasting purposes.

The Brisbane River Flood Study conducted by Sinclair Knight Merz (SKM) was completed in June 1998 and was concerned primarily with providing technically based flood development levels along the length of the Brisbane River within the confines of the Brisbane City Boundaries. The Ipswich Rivers Flood Studies are based on work completed for this study and therefore, the findings of the Brisbane River Flood Study are contained within this report.

Another study conducted on the Brisbane River was undertaken by the Snowy Mountains Engineering Corporation (SMEC) for Cities Commission. This study was completed on 1975 and focussed on flood damages and the economic losses associated with large floods in the Brisbane River.

Bremer River and Tributaries

A State of the Rivers Report was prepared by the Department of Natural Resources to assess the ecological and physical assessment of the conditions of streams in the Bremer River catchment. This study was completed in June 1996.

In 1987, Munro, Johnson & Associates completed a Flood Study for Moreton Shire Council to assess the flooding impacts in the Bremer River, Bundamba Creek, Blake Snake Creek, Franklin Vale Creek, Goodna Creek, Purga Creek, Six Mile Creek, Warrill Creek, Western and Woogaroo Creeks within the confines of the Moreton Shire boundary. The main aim of the study was to determine flood levels for Strategic Planning purposes.

The Bundamba Creek Flood Study was undertaken by CMPS&F and completed in June 1996. The aim of the study was to provide Ipswich City Council with a Floodplain Management Strategy for Bundamba Creek.

Sinclair Knight & Partners was commissioned by Moreton Shire Council to undertake a flood study for Sandy Creek (Camira). The aim of the study was to determine flood levels in the study area for existing and developed catchment conditions, determine appropriate flood mitigation measures and assess the impacts of the adopted flood mitigation measures on flood levels. This study was completed in May 1983.

A flood study for Woogaroo Creek was conducted for Moreton Shire Council to determine the flooding impacts in Springfield Estate (Neighbourhood 1) Camira. This study was prepared by Water Studies and was completed in 1993.

Aside from the Brisbane River Flood Study (SKM 1997) the two studies from the above list which are most applicable to the Ipswich Rivers Flood Studies are the DNR – Brisbane River Flood Study and CMPS&F – Bundamba Creek Flood Study. A review of these two studies has been conducted and the findings will be discussed in the subsequent section.

4.2 Review Discussion of Previous Studies

DNR – Brisbane River Flood Study

Hydrologic Model

The development of hydrologic models by DNR is documented in 'Brisbane River Flood Hydrology - Runoff Routing Model Calibration' (Vol 1 and 2, September 1991).

An overview of past flood investigations associated with Somerset Dam and Wivenhoe Dam was provided in the DNR report. The most significant of these studies were the original design flood estimates for Wivenhoe Dam completed in 1977 (Hausler and Porter, 1977) and a 1983 revision of these design flows (Weeks, 1983).

Runoff routing model techniques were applied in the 1983 revision and involved calibration against seven historical floods; July 1965, March 1967, June 1967, January 1968, December 1971, January 1971 and January 1976.

WT42PC, a RORB type runoff routing model, was used by DNR in their 1991 study. A total of 24 individual models were set up corresponding to streamgauge locations and calibrated against historical data.

The seven floods used by Weeks (1983) were applied by DNR in addition to floods in June 1983, early April 1989 and late April 1989.

The subdivision of the Brisbane River catchment into 24 separate models, linked together such that hydrographs from upstream models form inputs into downstream models, is a technique adopted by DNR from a flood analysis conducted for Warragamba Dam, Sydney (Deen, Craig, Sable 1988).

During the calibration phase, recorded hydrographs were used as upstream inflows into several of the WT42PC models in preference to predicted hydrographs. For example, recorded hydrographs available for Brisbane River at Linville and Emu Creek at Boat Mountain were used as direct inflows into the WT42PC model of the Brisbane River upstream of Gregors Creek (refer to **Figure 3.1: Stream Gauge Locations** for gauge locations).

The preferential use of recorded hydrographs in place of predicted hydrographs from upstream WT42PC models made it difficult to review the performance of the full network model of the Brisbane River (comprising of the individual WT42PC models linked together) in predicting flood hydrographs at the lower reaches of the catchment.

Calibration of the individual WT42PC models was based on matching of peak discharges and flood volumes by adjusting rainfall loss rates and catchment storage parameters (k and m).

The initial loss - continuing loss type of rainfall loss was used in the model calibration. Initial loss rates were adjusted to match the rising limb of the recorded hydrograph. A significant variability in loss rates was noted, both between the individual models for the same storm and over the range of storms that were modelled. Generally the initial loss ranged from 0 to 300 mm and continuing loss rate varied from 0.1 to 9.7 mm/hr. The upper end of the adopted losses are higher than expected for South East Queensland (AR&R, 1987).

The catchment storage parameter, k, was varied within each WT42PC model for each calibration event, generating an extensive set of k values. A k value was nominated for each individual model based on a weighted average; the bias being in proportion to the peak discharge of the calibration event. On this basis, the model parameters were weighted towards larger magnitude floods.

Hydraulic Model
The hydraulic model used for the DNR – Brisbane River Flood Study was RUBICON and as MIKE11 was the desired hydraulic model for this study, a detailed review of this model was not required.

CMPS&F – Bundamba Creek Flood Study
Hydrologic Model
The Bundamba Creek Flood Study (CMPS&F 1996) was reviewed. The hydrologic models used for the study were AWBM and URBS.

No gauging station data was available for the Bundamba Creek Catchment and hence, a calibration was conducted on an adjacent catchment (Purga Creek) to establish set catchment parameters. It was assumed that since Bundamba Creek Catchment and Purga Creek Catchment are adjacent catchments, the catchment parameters would be similar.

The purpose of undertaking AWBM modelling of the catchments was to establish a set of loss parameters for both the Bundamba Creek and Purga Creek Catchments. The loss parameters determined for Purga Creek were 0 – 55 mm initial loss and a proportional loss of 0.36. Since the catchments are similar, these losses were adopted for the Bundamba Creek Catchment.

An URBS model was set up for Purga Creek and a set of catchment parameters were established. An URBS model of Bundamba Creek was then developed using 'Split Model' format which separates the catchment routing and channel routing in each sub-catchment. The URBS model for Bundamba Creek consisted of 82 sub-catchments with 117 reaches.

As URBS is not used in the Ipswich Rivers Flood Studies, further review of the hydrologic model was not undertaken.

Hydraulics

A MIKE11 (Ver. 3.26) hydraulic model of Bundamba Creek was developed. This model extended from the Bremer / Bundamba confluence and extended just upstream of Daly's Lagoon (approximately 25km). The creek was modelled using five branches with cross-sections located at approximately 250m intervals. All road crossings were modelled as combination weir / culvert structures.

A total of 18 inflow boundaries and one tailwater boundary at the Bremer / Bundamba confluence were used.

The hydraulic model was calibrated on the December 1991 flood event and verified with the June 1983, February 1976 and March 1974 events. Flood level information was available at Brisbane Road, Blackstone Road and Harding Street via flood alert gauges.

Tailwater levels for the calibration / verification were assumed to be the same levels as recorded at the David Trumpy Bridge for the December 1991 flood event and the Gledson Street stage hydrographs for the verification events. As these stage hydrographs are upstream of the Bremer / Bundamba Creek confluence, it is considered that the adopted tailwater levels used would be higher than those levels at the actual river's confluence.

Calibration of the hydraulic model was achieved by varying MIKE11 channel roughness values until good agreement was obtained between predicted and recorded flood levels. Corresponding cross-sections, conveyance and water level data was extracted from the MIKE11 calibration results and a relative Manning's n roughness distribution was determined for each cross-section. The GLENFLO2D program was also used to generate a Manning's n roughness in the waterway. The GLENFLO2D program was then used to compute conveyance for each cross-section for a full range of stage heights. This information was used in MIKE11 by converting the GLENFLO2D data to equivalent total waterway Manning's n for the MIKE11 program.

GLENFLO2D was developed to account for the hydraulic mechanisms between main channel flows and floodplain flows. Studies in this area have found that bands of trees on both sides of the main channel cause an increase in interaction between the main channel and floodplain.

5. Hydrologic Modelling

5.1 RAFTS Model Description

The objective of the hydrologic analysis was to develop a model that would adequately reproduce historical storm events and reliably predict design flood discharge hydrographs for the following catchments:

- Brisbane River Catchment
- Bremer River Catchment
- Bundamba Creek Catchment
- Warrill Creek Catchment
- Purga Creek Catchment
- Deebing Creek Catchment
- Ironpot Creek Catchment
- Mihi Creek Catchment
- Sandy Creek Catchment (Chuwar)
- Six Mile Creek Catchment
- Goodna Creek Catchment
- Woogaroo Creek Catchment
- Sandy Creek Catchment (Camira).

The runoff routing model, RAFTS, was used for hydrologic modelling purposes. This program was originally developed by Willing and Partners and the Snowy Mountains Engineering Corporation in 1974 and was first distributed as the Regional Stormwater Model (RSWM).

RAFTS has been applied to watersheds ranging from rural to fully urban with catchment areas varying from less than 1 hectare to several thousand square kilometres. Since the 1980's, WP Software have added refinements to the RAFTS software including an EXPERT graphical environment, unsteady flow routing and simulation of retarding basin storages.

5.2 Comparison with URBS Model

As outlined in Section 4, the Department of Natural Resources developed a series of WT42 models of the Brisbane River catchment as part of the flood management of Wivenhoe Dam and Somerset Dam. This program has become the basis of a runoff routing model, URBS, developed jointly by the Brisbane City Council and Department of Natural Resources. URBS has been modified to become an integrated flood forecasting model and is used for this purpose by the Bureau of Meteorology. Presently, the Bureau has an operational URBS model of the Brisbane River catchment as part of its flood alert system.

Both URBS and RAFTS have the capacity to model separately the catchment storage effects (ie. routing along overland flowpaths and minor tributaries draining to the major creeks) and channel storage (ie. routing associated with the major creeks and channels). The URBS and RAFTS modelling approaches are different and some of these differences are summarised in **Table 5.1: Comparison of URBS and RAFTS Storage Routing.**

Table 5.1: Comparison of URBS and RAFTS Storage Routing

RAFTS Model	URBS Model
Catchment Storage	
$S = \left(\frac{0.285A^{0.52}}{(1 + U)^{1.97} S_c^{0.5}} \right) Q^m$ where S = storage (m³h/s) A = catchment area (km²) Q = discharge (m³/s) U = fraction urbanisation S_c = drainage slope (%) m = storage non-linearity exponent (default = 0.715) Also RAFTS has optional storage factor, PERN, based on the average roughness of the catchment.	$S = \left(\frac{\beta A^{0.5} (1 + F)^2}{(1 + U)^2} \right) Q^m$ where S = storage (m³h/s) A = catchment area (km²) Q = discharge (m³/s) U = fraction urbanisation F = fraction forest β = lag parameter m = storage non-linearity exponent (default = 0.8)
Channel Routing	
Two options are available 1. Simple lag where flood hydrograph is displaced in time by a user-specified delay with zero attenuation. 2. Muskingum – Cunge Routing with routing parameters are calculated from slope, geometry and roughness.	One option 1. Muskingum Routing with direct user inputs of routing parameters (x and α)

5.3 RAFTS Model Setup

Model Layout

A RAFTS model of the Brisbane River catchment was developed for the Brisbane River Flood Study to predict runoff hydrographs from rainfall for both historic and design storms. This model has been refined and the Bremer River, Bundamba Creek, Warrill Creek, Purga Creek, Deebing Creek, Ironpot Creek, Mihi Creek, Sandy Creek (Chuwar), Six Mile Creek, Goodna Creek, Woogaroo Creek and Sandy Creek (Camira) catchments have been further delineated to produce additional run-off hydrographs at required locations.

The schematisation of the model is shown in the following series of plans included in this report:

- **Figure 5.1a: - RAFTS Layout - Bremer and Lower Brisbane**
- **Figure 5.1b: - RAFTS Layout - Brisbane City Insert**
- **Figure 5.1c: - RAFTS Layout - Ipswich Insert**
- **Figure 5.1d: - RAFTS Layout - Redbank Insert**
- **Figure 5.1e: - RAFTS Layout - Lockyer**

- **Figure 5.1f: - RAFTS Layout - Somerset and Wivenhoe**
- **Figure 5.1g: - RAFTS Layout - Upper Brisbane River**

A single RAFTS model was setup that has full coverage of the Brisbane River catchment. The breakup of the model layout into the four main geographical areas shown in **Figure 5.1a** to **5.1g** was done for presentation purposes only.

The RAFTS model consists of several major elements as follows;

- **General Nodes** - the 'building blocks' of the model. Routing of flows from each catchment local to each node is routed through a conceptual storage (see **Table 5.1** for details on catchment storage). Many of the nodes coincide (or are close to) stream gauges which enable comparison between recorded and predicted hydrographs.

- **Basin Nodes** - are a special type of RAFTS node in which inflow hydrographs are routed through a user specified storage. In the case of the Ipswich River Flood Studies, basin nodes were used to model dam storages and significant temporary flood storage zones within the river system.

- **Links** - provide a connection between nodes and include channel routing effects (see **Table 5.1** for details on channel routing).

The delineation of RAFTS subarea boundaries, and hence the basic model structure, is based on the DNR WT42 models used for real time flood forecasting. A consistent node numbering system has been applied. In several cases 'dummy' nodes have been added (these are denoted with the suffix '#' or '+').

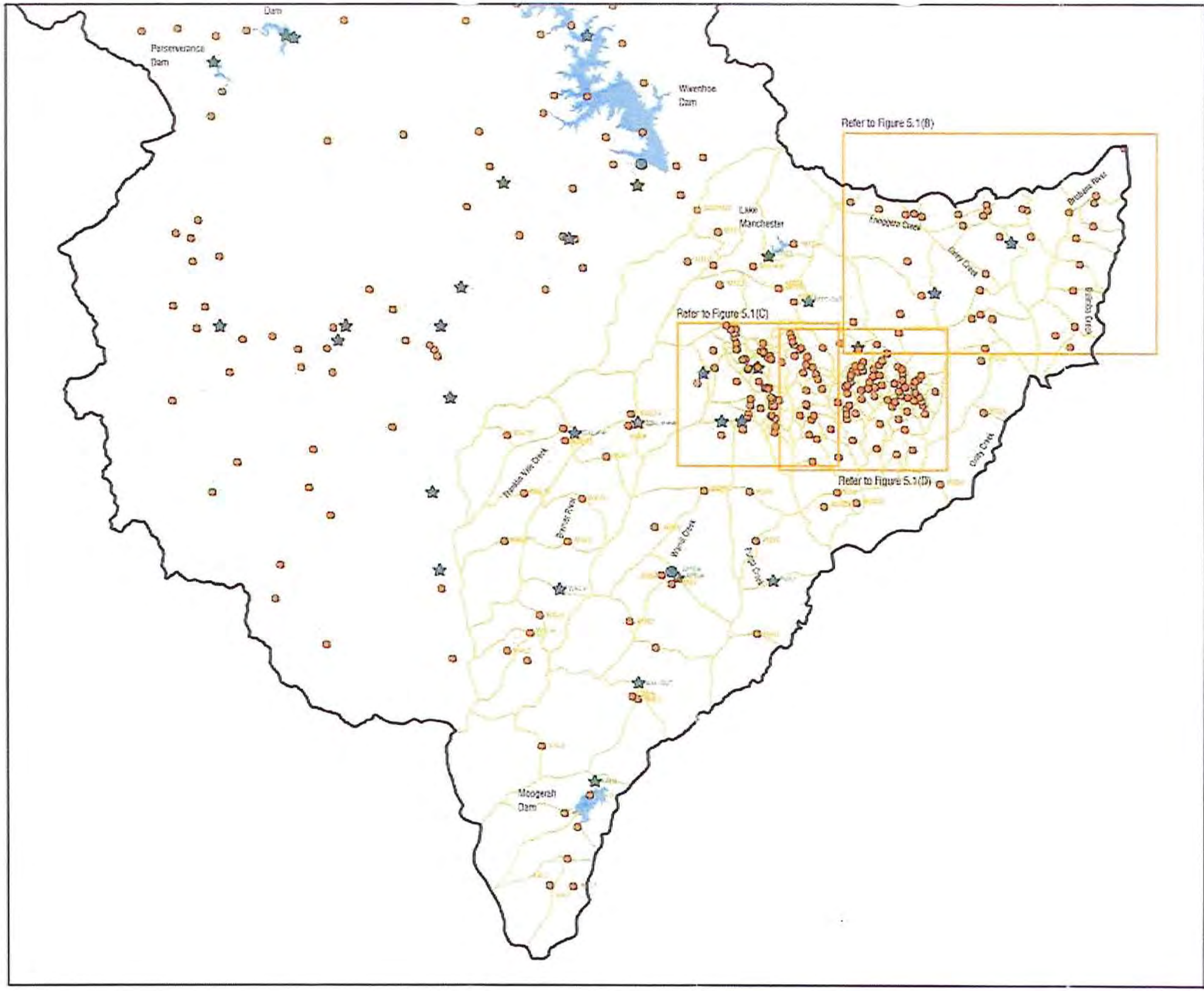
RAFTS Model Parameters

During the model setup phase, the input of several types of model parameters was required prior to undertaking RAFTS calibration and verification:

- **Subarea Properties** - include the local catchment area, the percentage impervious of the catchment surface, the vectored slope of the sub-catchment and a surface roughness factor (PERN).

- **Link Properties** - generally, hydrographs were lagged between subarea nodes based on travel time.

The subarea and link properties were incorporated into the RAFTS model based on available data. Parameters including area, percentage impervious, and slope were fixed. Surface roughness factor and link travel times were subject to adjustment during the course of model calibration.



Ipswich City Council

IPSWICH RIVERS FLOOD STUDY

RAFTS LAYOUT

BREMER AND LOWER BRISBANE

FIGURE 5.1 (A)

LEGEND

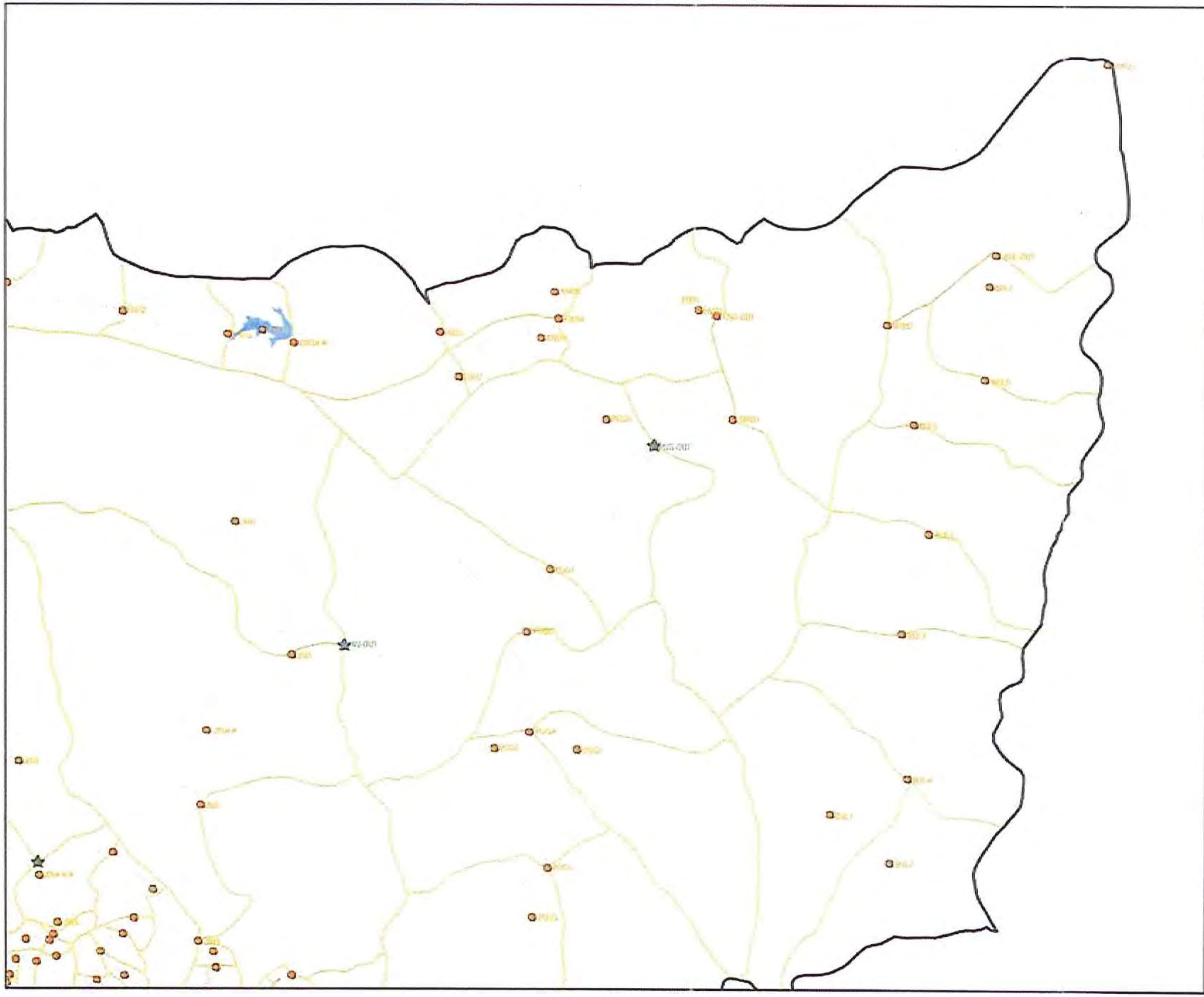
- Stream Gauge
- RAFTS General Node
- RAFTS Basin Node
- RAFTS Node at Stream Gauge
- RAFTS Link
- RAFTS Sub-Area Boundary
- Catchment Boundary

Data Coverage

NORTH

SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd for Ipswich City Council
RE04390
04390-20



Ipswich
City Council

IPSWICH RIVERS FLOOD STUDY

RAFTS LAYOUT
BRISBANE CITY INSERT

FIGURE 5.1 (B)

LEGEND

- Stream Gauge
- RAFTS General Node
- RAFTS Basin Node
- RAFTS Node at Stream Gauge
- RAFTS Link
- RAFTS Sub-Area Boundary
- Catchment Boundary

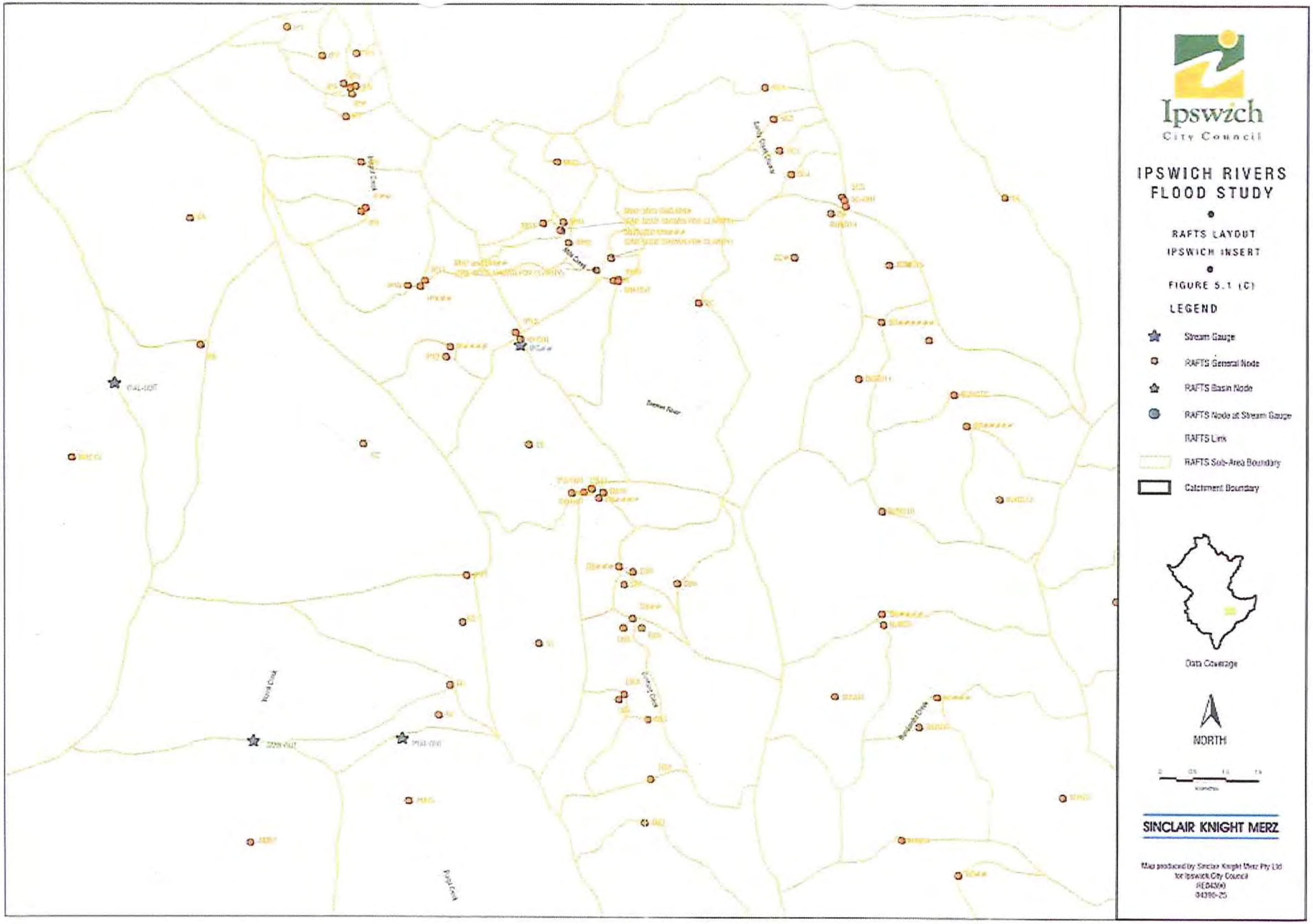
Data Coverage

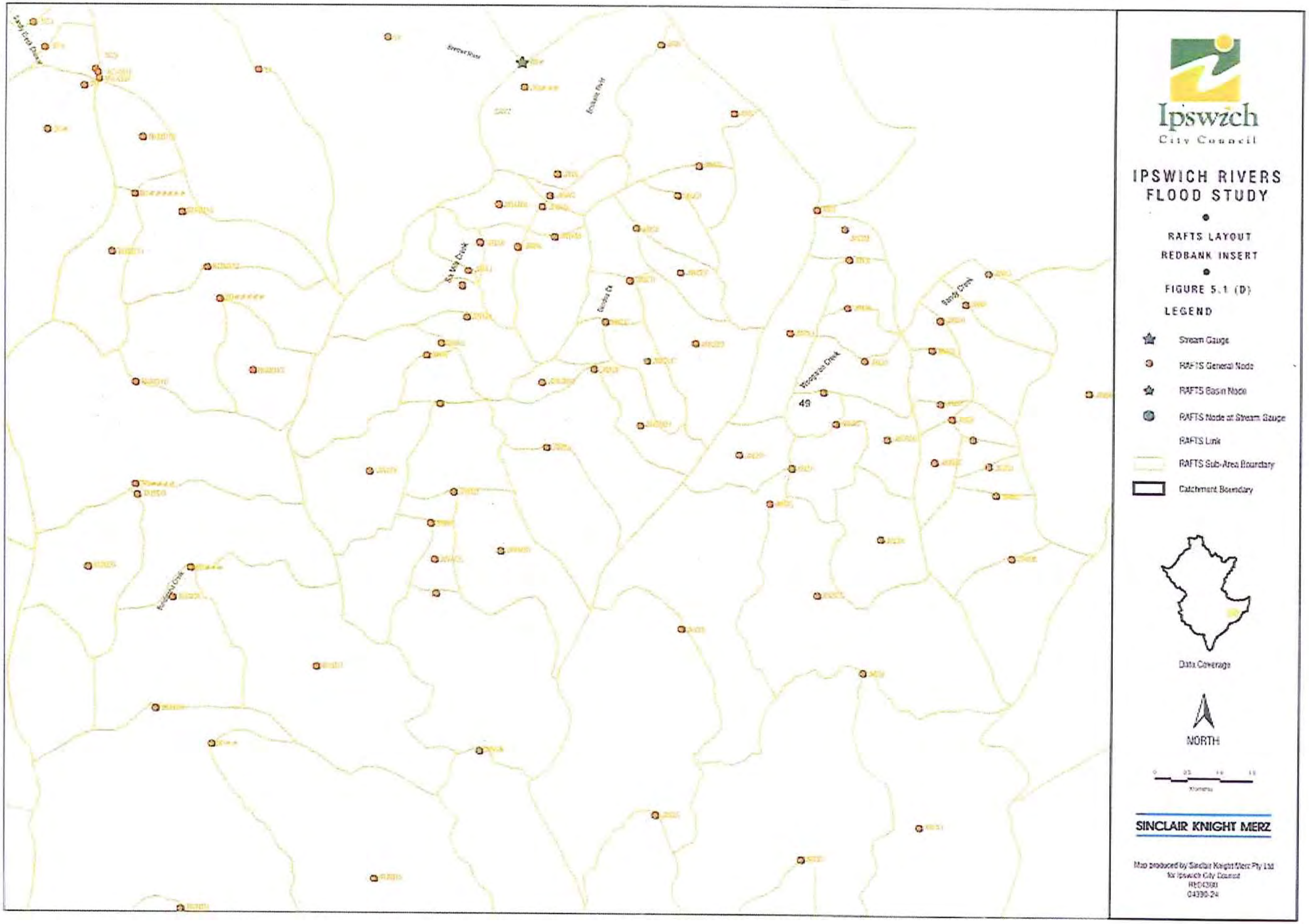
NORTH

0 1 2 3
Kilometres

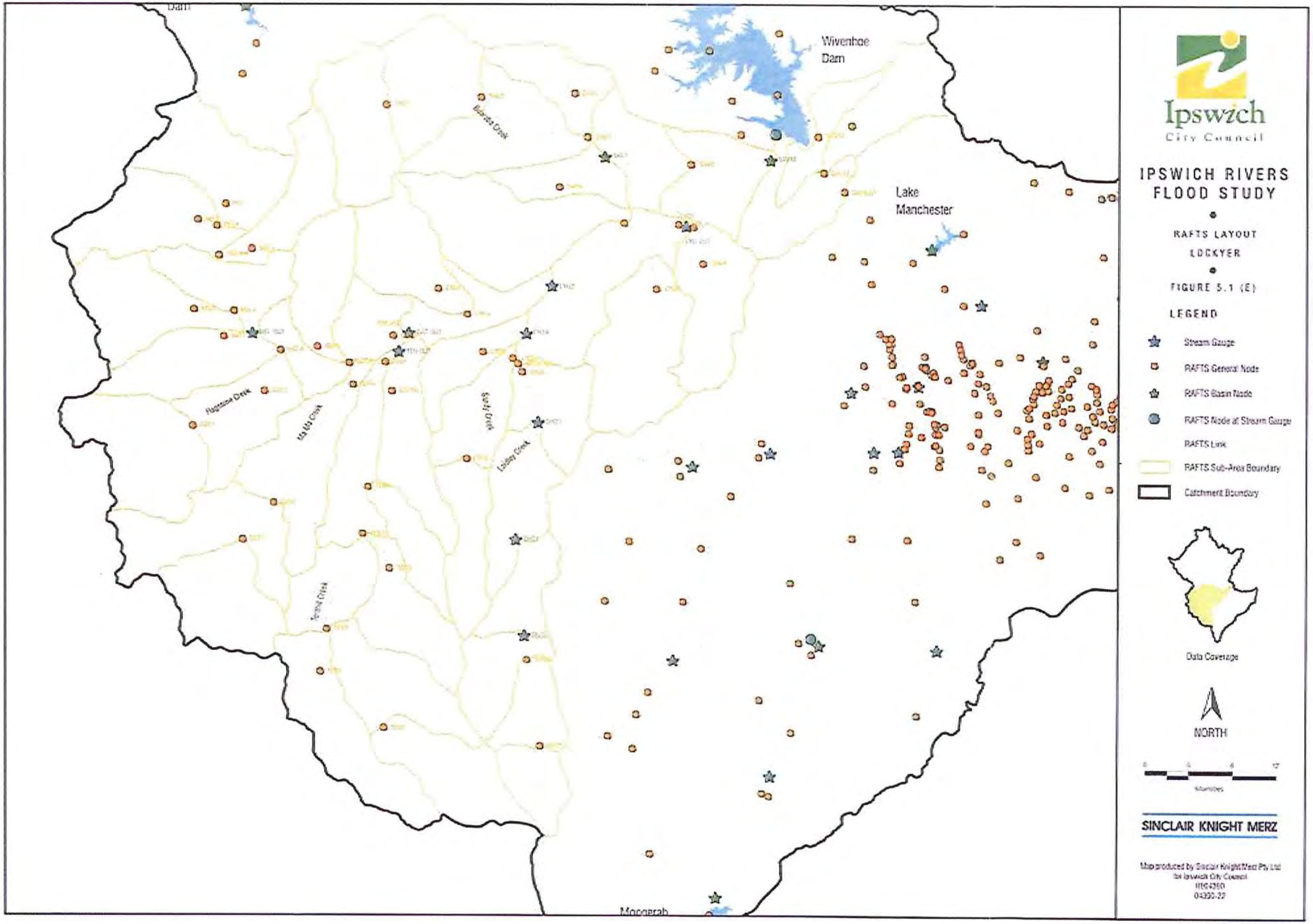
SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council
RE04300
04300-20

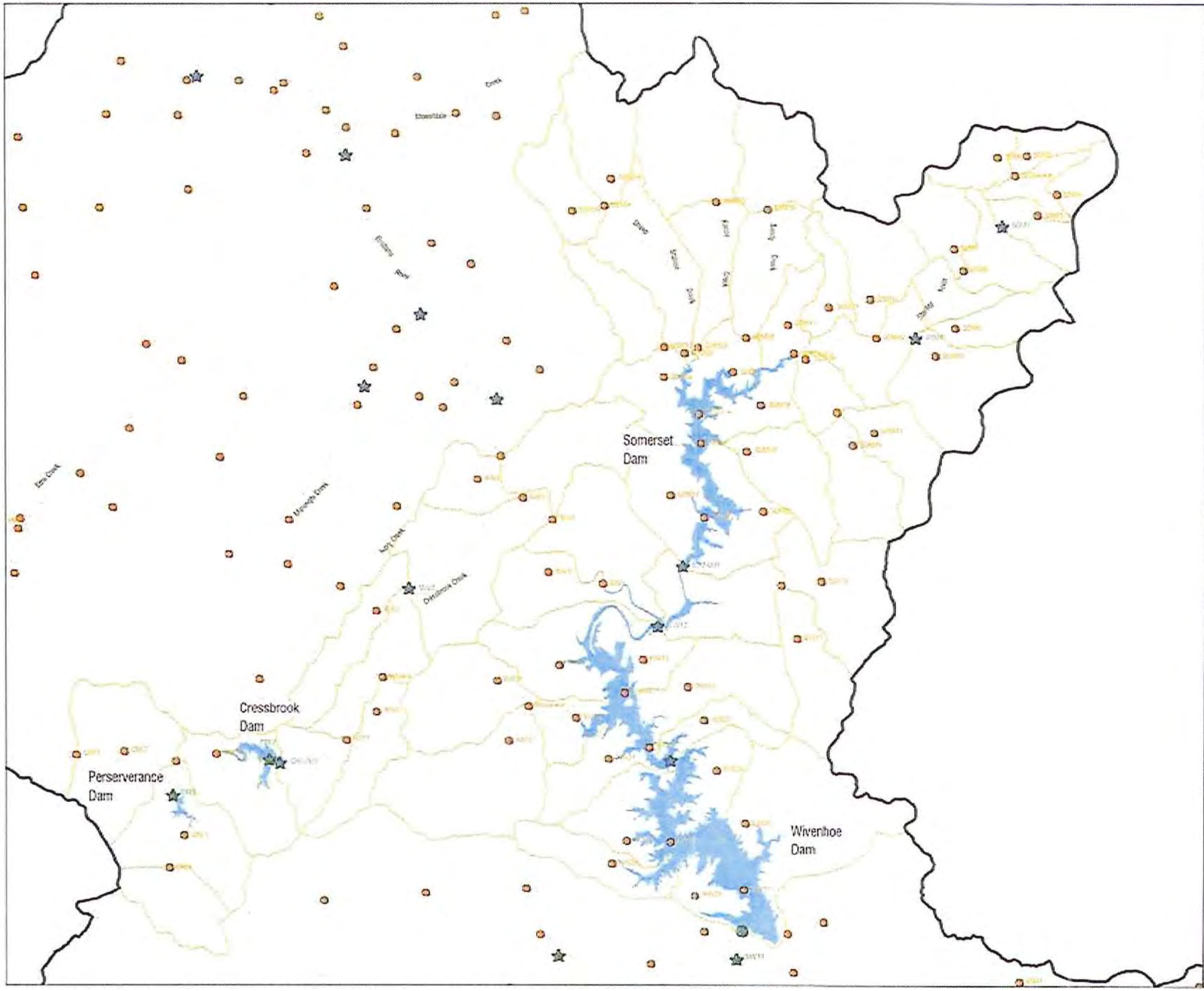

Ipswich
City Council
IPSWICH RIVERS
FLOOD STUDY
RAFTS LAYOUT
IPSWICH INSERT
FIGURE 5.1 (C)
LEGEND
Stream Gauge
RAFTS General Node
RAFTS Basin Node
RAFTS Node at Stream Gauge
RAFTS Link
RAFTS Sub-Area Boundary
Catchment Boundary
Data Coverage
NORTH
SINCLAIR KNIGHT MERZ
Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council



Ipswich City Council
IPSWICH RIVERS FLOOD STUDY
RAFTS LAYOUT
REDBANK INSERT
FIGURE 5.1 (D)
LEGEND
Stream Gauge
RAFTS General Node
RAFTS Basin Node
RAFTS Node at Stream Gauge
RAFTS Link
RAFTS Sub-Area Boundary
Catchment Boundary
Data Coverage
NORTH
SINCLAIR KNIGHT MERZ
Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council
Woogaroo Creek
Sandy Creek
Six Mile Creek
49



Wivenhoe Dam
Lake Manchester
Moogerah
Dam
Bulanda Creek
Flagstone Creek
Ma Ma Creek
Sandy Creek
Lockyer Creek
Tenthill Creek
Ipswich City Council
IPSWICH RIVERS FLOOD STUDY
RAFTS LAYOUT
LOCKYER
FIGURE 5.1 (E)
LEGEND
Stream Gauge
RAFTS General Node
RAFTS Basin Node
RAFTS Node at Stream Gauge
RAFTS Link
RAFTS Sub-Area Boundary
Catchment Boundary
Data Coverage
NORTH
Kilometres
SINCLAIR KNIGHT MERZ
Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council



Ipswich City Council

IPSWICH RIVERS FLOOD STUDY

RAFTS LAYOUT
SOMERSET AND WIVENHOE

FIGURE 5.1 (F)

LEGEND

- Stream Gauge
- RAFTS General Node
- RAFTS Basin Node
- RAFTS Node at Stream Gauge
- RAFTS Link
- RAFTS Sub-Area Boundary
- Catchment Boundary

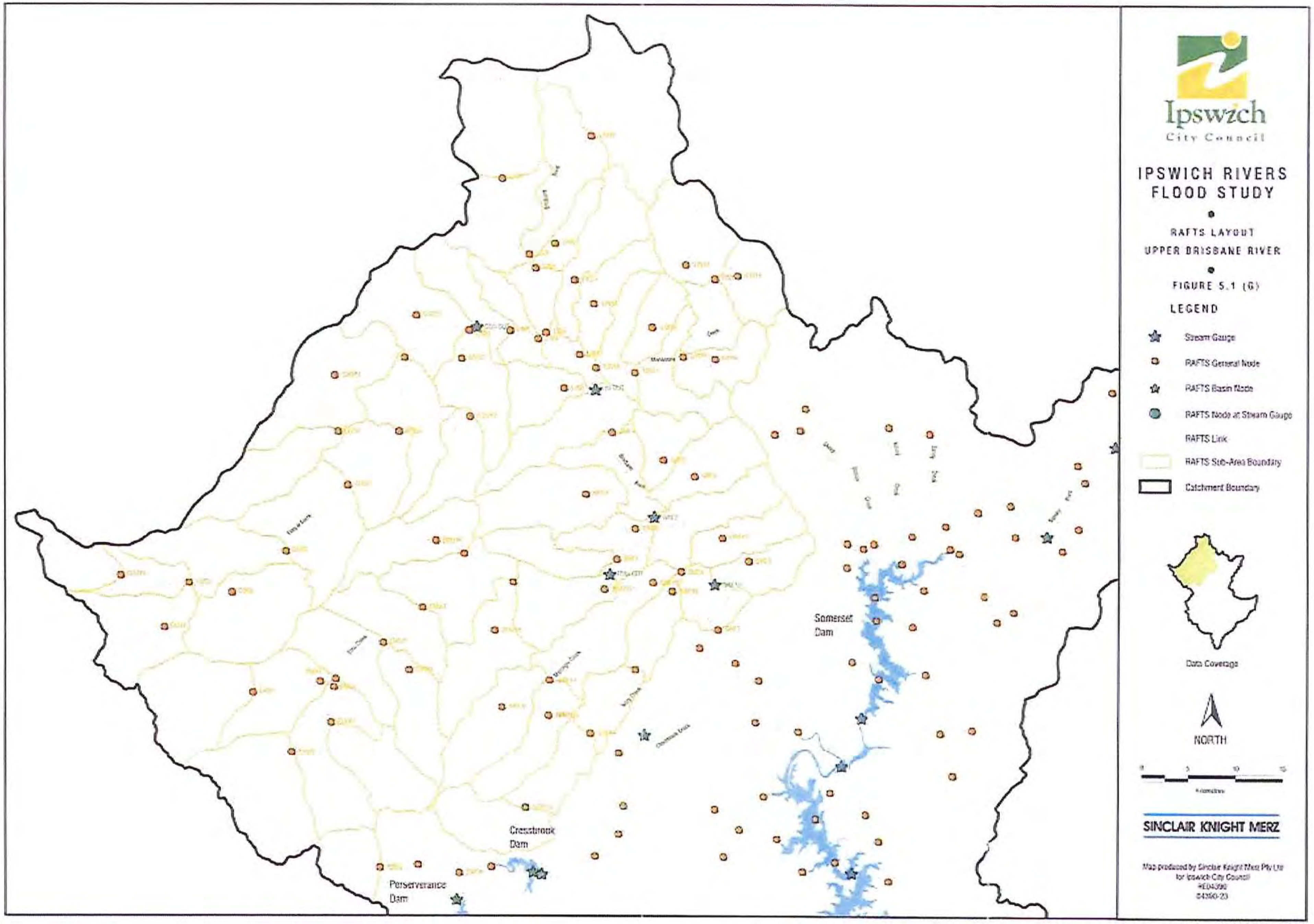
Data Coverage

NORTH

0 4 8 12
Kilometres

SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council
R04380
04380-21


Somerset
Dam
Cressbrook
Dam
Perseverance
Dam
Ipswich
City Council
IPSWICH RIVERS
FLOOD STUDY
RAFTS LAYOUT
UPPER BRISBANE RIVER
FIGURE 5.1 (G)
LEGEND
Stream Gauge
RAFTS General Node
RAFTS Basin Node
RAFTS Node at Stream Gauge
RAFTS Link
RAFTS Sub-Area Boundary
Catchment Boundary
Data Coverage
NORTH
0
5
10
15
Kilometres
SINCLAIR KNIGHT MERZ
Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council
RE04390
04390-23

The basis of parameter selection during the RAFTS model setup phase was:

- **Catchment areas** - the area of the local catchment assigned to each node was based on the catchment subdivision of the DNR flood forecasting models. These node areas were typically of the order of 5 000 to 10 000 ha. Catchment subdivision within the Ipswich areas were delineated further so that discharges could be predicted at the desired locations. These node areas were in the order of 50 ha to 500 ha.

- **Percentage Impervious** - zero percentage impervious was adopted for most of the catchment, given its predominant rural and natural land uses. RAFTS derives an equivalent fraction urbanisation (referred to as U in **Table 5.1**) using the percentage impervious assigned to each node. On this basis, the majority of the catchment also had a zero fraction urbanisation. In the Brisbane and Ipswich metropolitan areas, the assumed percentage impervious varied from 20 to 60% to account for catchment urbanisation.

- **Slope** - a slope of 2% was globally applied throughout the RAFTS model for the Brisbane River RAFTS model (developed for the Brisbane River Flood Study). This assumption lead to a constant factor in the catchment storage relationship, making it more consistent with the URBS model approach. While this method was appropriate for the Brisbane River Catchment, it was considered that where the RAFTS model was to be refined for the Ipswich Rivers Flood Studies, it was considered that average slope of the smaller, refined catchments would better represent catchment storage/response. Hence average slopes were used in these subareas.

  This decision was based on the number of recorded hydrographs in the Brisbane River Catchment compared to the number of recorded hydrographs in the extents of the Ipswich Rivers Flood Studies. Generally there is little or no recorded hydrograph information along the Bremer River, Bremer River tributaries and Brisbane River tributaries and therefore, calibration on these rivers/creeks cannot be conducted. The adoption of the average slope for the refined subareas will provide a better representation of catchment storage/response. The remainder of the RAFTS hydrological model uses a constant catchment slope of 2% as there were significant recorded hydrographs to perform calibration.

- **Surface roughness** - this is an empirical factor based on the average Mannings 'n' value of 0.05, consistent with rural landuse. Mannings 'n' of the catchment surface were globally applied in the RAFTS model and varied during model calibration.

- **Link lag** - initial estimates of lags between nodes were based on interpretation of travel time plots between stream gauges supplied by the Hydrology Section, Bureau of Meteorology. These plots were based on the time difference of the incidence of peak gauge height for a range of historical floods.

Rainfall Losses
An initial loss - continuing loss model, similar to that used by DNR, was employed in the RAFTS calibration. These losses are used to predict the runoff volume generated from the catchment in response to rainfall and includes two components:

- **Initial Loss** - a loss (in mm) accounting for infiltration effects that is deducted from rainfall prior to the occurrence of surface runoff. Typical values of Initial loss range from 0 to 150 mm.

- **Continuing Loss** - a constant loss rate (in mm/hr) that is deducted from the rainfall over the duration of the storm. Typical continuing loss rates fall in a range from 0 to 3.0 mm/hr.

Initial loss and continuing losses were assumed to be uniform within each of the six broad areas shown in **Figure 2.2: Brisbane River Sub-catchments.**

Loss parameters were selected based on matching recorded peak discharges, volumes and matching the rising limb of recorded hydrographs. While adjusting catchment storage may satisfy peak discharges for a particular event, recorded volumes and rising limb requirements cannot be satisfied by varying catchment storage. In order to match each peak discharges, volumes and rising limbs, initial and continuing loss parameters are adjusted for each historical event until good calibration is achieved.

Initial loss is somewhat dependent on antecedent catchment conditions however continuing loss is related to soil properties and infiltration characteristics. It could therefore be expected that initial losses will vary but continuing losses would remain fairly constant for all flood events in each particular catchment. This is rarely the case as other factors such as catchment development, rainfall depths and rainfall intensities vary significantly throughout the catchment. Initial and continuing losses are used to modify catchment response and if losses, flood volumes and peak discharges are within acceptable limits this is considered to be an acceptable approach.

Basin Nodes

Basin nodes were used in the RAFTS model to account for temporary flood storage effects at key locations within the Brisbane River System and its tributaries. The stage-storage discharge relationship, assigned to each of these nodes, was based on matching the shape and peak discharge of predicted and gauged hydrographs downstream of the nodes.

Basin nodes were also used in the RAFTS model to simulate existing dam storages. For the smaller dams, a simple stage-storage, volume - outflow discharge curve based on the dam outlet configuration and the storage volume was used. This data was supplied by DNR and was applied to the dams listed in **Table 2.1: Major Dams in the Brisbane Valley** with the exception of Wivenhoe and Somerset Dams. It was assumed that the dam storage level was at full supply level at the start of each calibration flood.

Somerset Dam and Wivenhoe Dam are major flood mitigation structures and the regulation of outflows by setting of the dam spillway gates is governed by a set of flood operation rules. Spillway operation depends in part on flooding conditions prevailing downstream of Wivenhoe Dam due to less regulated tributary flows such as Lockyer Creek.

During the RAFTS model calibration phase, recorded or synthetic hydrographs of Somerset and Wivenhoe Dam outflows were used as direct inputs. This approach effectively divided the Brisbane Valley catchment into the following (based on the sub-catchments shown on **Figure 2.2**):

- **Somerset** - upstream of Somerset Dam and hence modelling inflows to this dam.

- **Upper Brisbane and Wivenhoe** - upstream of Wivenhoe Dam including upper Brisbane River, Cooyar Creek, Emu Creek and Cressbrook Creek. Regulated flows from Somerset Dam were directly input based on historical data.

- **Lockyer, Bremer and Lower Brisbane** - the remainder of the Brisbane River catchment including Lockyer Creek, Bremer River and the lower Brisbane River. In this case, outflow hydrographs from Wivenhoe Dam were used as direct inputs.

For the case of the 1974 historical flood which occurred prior to the completion of Wivenhoe Dam in 1985, the division of the Brisbane Valley catchment simplified to:

- **Somerset** - upstream of Somerset Dam

- Upper Brisbane, Wivenhoe, Lockyer, Bremer and Lower Brisbane - the remainder of the Brisbane River catchment and downstream of Somerset Dam. Recorded outflow hydrographs from this dam were used as inputs.

Moogerah Dam was included in all model runs as no recorded outflow hydrographs for the historical events were available. Stage versus discharge and stage versus storage relationships for Moogerah Dam were supplied by the DNR and these relationships were used directly in the basin node at Moogerah Dam.

5.4 RAFTS Model Calibration

General Approach
The approach taken in model calibration was to derive a single set of catchment and channel routing parameters that would be applicable to the entire range of historical floods under consideration. Rainfall loss rates could be adjusted depending on antecedent moisture conditions and other factors.

Calibration against data recorded for a minimum of four floods for the entire Brisbane River Catchment was required, including the January 1974 flood.

As part of the Brisbane River Flood Study, four additional floods were used to verify the hydrological model. Verification was not considered necessary as part of the Ipswich Rivers Flood Studies because the hydrologic model used for the Ipswich Rivers Flood Studies was primarily the Brisbane River Flood Study hydrologic model. The refinements made to the Brisbane River Flood Study model for the Ipswich Rivers Flood Studies model, were considered minimal, hence re-verification was considered unnecessary. The results for the Brisbane River verification events have not been included in this report however they are presented in the Brisbane River Flood Study Report (SKM 1999) should they be required.

Achieving a consistency between RAFTS and MIKE11 predictions of flood discharge, at key points within the study area, was also a requirement of the calibration process.

The focus of the RAFTS modelling is to generate inflow hydrographs for Phase 1 and Phase 2 of the Ipswich Rivers Flood Studies MIKE11 model. A high priority was achieving an acceptable calibration at locations towards the lower reaches of the Brisbane River, the Bremer River, the Bremer River Tributaries and the Brisbane River Tributaries. Stream gauges distributed within the catchment at key points of interest (refer to primary stream gauges in Section 3.1) were also given high priority unless a poor rating at the site was reported.

49

Selection of Calibration Floods

A summary of major floods for the Brisbane River Catchment and the availability of hydrological data (rainfalls and streamflows) and hydraulic data (flood levels and discharges in the Brisbane and Ipswich metropolitan areas) is given in **Table 5.2: Data Availability for Major Historical Floods.**

Table 5.2: Data Availability for Major Historical Floods

Flood	Hydrologic Data	Hydraulic Data
February 1931	✓	✓
March 1955	✓	✓
July 1965	✓	
March 1967	✓	
June 1967	✓	✓
January 1968	✓	✓
December 1971	✓	
July 1973	✓	✓
January 1974	✓	✓
January 1976	✓	✓
June 1983	✓	✓
April 1989 a	✓	✓
April 1989 b	✓	✓
December 1991		✓
May 1996	✓	✓

Note:

1. Floods modelled by DNR for validation of WT42 and RUBICON models are shaded.
2. Limited data also available for the February 1893 flood.

The historical floods can be grouped as:

- **Pre-Somerset Dam** - Floods that occurred prior to the construction of Somerset Dam. There is some confusion regarding the date in which Somerset Dam was constructed. Although the dam was completed in 1959, construction began in 1943 and it is believed that the war caused construction to be ceased. At this point, it is believed that the dam was completed all except for the radial area flood spillway gates.

- **Pre-Wivenhoe Dam** - floods that occurred prior to the construction of Wivenhoe Dam which was operational in 1985. The June 1983 flood occurred during the construction phase when the dam spillway was at a near completion stage.

- **Post-Wivenhoe Dam** - floods that occurred after completion of Wivenhoe Dam in 1985.

Table 5.3: Historical Calibration Events provides a list of the events used in the RAFTS and MIKE11 model validation. The selection of historical floods took into account various factors including the availability of both hydrologic and hydraulic data sets for the same flood. A higher weighting towards recent floods was applied as these tended to have more data available for calibration purposes.

The floods used for RAFTS and MIKE11 model validation covered a historical period from 1974 to 1996.

Table 5.3: Historical Calibration Events

Event	Period of Event	Type
January 1974	24/01/74 to 28/01/74	Calibration
June 1983	20/06/83 to 23/06/83	Calibration
Late April 1989	23/04/89 to 27/04/89	Calibration
December 1991	11/12/91 to 14/12/91	Calibration
May 1996	31/04/96 to 07/05/96	Calibration

Note: 1. The December 1991 event was used for Bundamba Creek Calibration only.

Major Dam Discharges

A major consideration in the RAFTS calibration was the flood regulation characteristics of the two major dams; Somerset Dam and Wivenhoe Dam. The hydrologic effect of Somerset Dam started after its completion in 1959 and full operation of the larger Wivenhoe Dam was initiated in 1985.

Estimates of inflow and outflow hydrographs at both dams for a range of historical floods were available and are compiled as **Figure 5.2: Wivenhoe Dam Discharges** and **Figure 5.3: Somerset Dam Discharges.** These are synthetic hydrographs produced by Brisbane City Council and were estimated from measured storage levels and records of spillway gate settings. In the case of Wivenhoe releases, DNR suggests that the outflow hydrographs may be over estimated by between 15 to 20 percent, especially for the lesser floods such as late April 1989 (SEQWB, October 1994).

No dam releases for either Wivenhoe Dam or Somerset Dam were reported for the May 1996 flood.

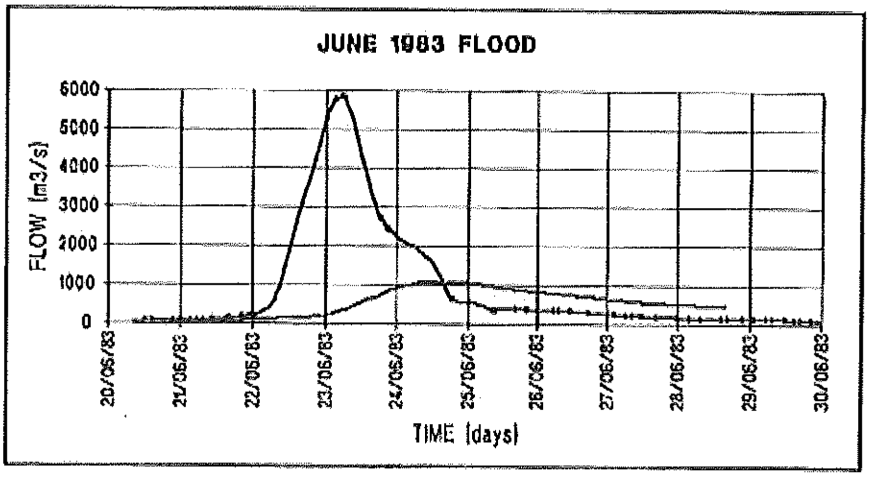
Calibration Process

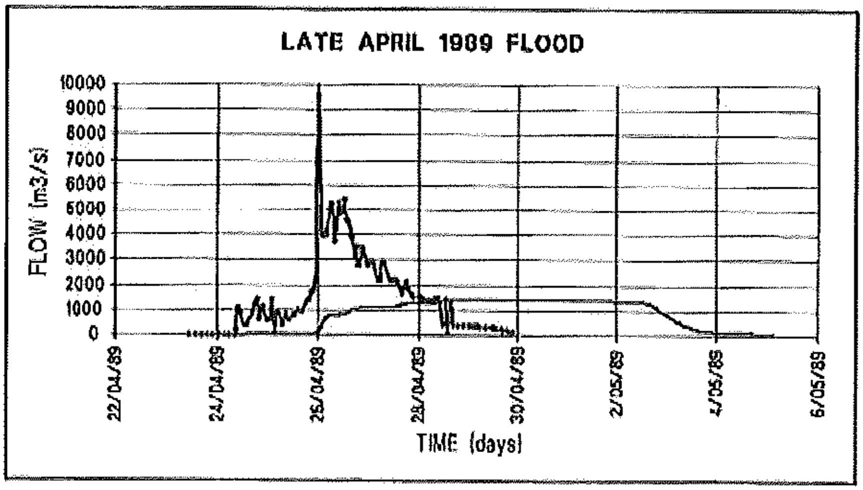
The calibration process for the Ipswich River Flood model involved a combination of matching predicted discharges and flood levels with historically recorded discharges and flood levels. To achieve a good calibration it was necessary to calibrate the RAFTS hydrological model and the MIKE11 hydraulic model simultaneously. This ensured that factors such as channel routing, channel storage and discharges were consistent between the two models. This methodology also accounted for variation in ratings at gauges that are affected by backwater and tide.

FIGURE 5.2

SINCLAIR KNIGHT MERZ

IPSWICH RIVERS FLOOD STUDY
WIVENHOE DAM DISCHARGES

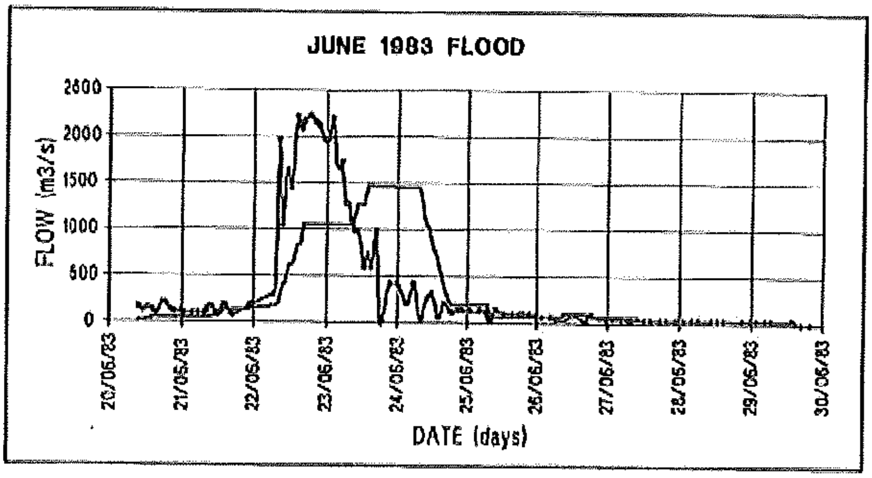


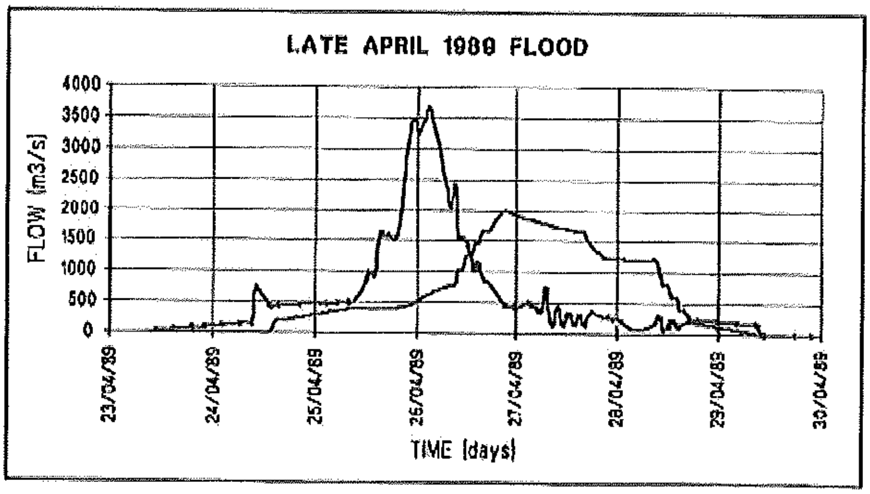


LEGEND
—— INFLOW
—— OUTFLOW

FILE NAME: 04390-10 DISK N°: U:\FWUD JOB N°: RE04390 DATE: 3-2-99
PLOT SCALE: 1:1(A4)

FIGURE 5.3
IPSWICH RIVERS FLOOD STUDY
SOMERSET DAM DISCHARGES





LEGEND
—— INFLOW
—— OUTFLOW

One of the difficulties in calibrating the Ipswich Rivers Flood studies models was that a large percentage of the gauges within the Brisbane and Ipswich Metropolitan areas are affected by tides and backwater. It was therefore necessary to conduct an iterative calibration process between the hydraulic and hydrologic models.

This process also assisted in the calibration of the tributaries and creeks with no historical recorded streamflow information.

5.5 RAFTS Calibration - December 1991 Flood

The December 1991 flood calibration was conducted for Bundamba Creek only. This was the largest historical flood event in Bundamba Creek in recent history and is the largest recorded local flood event for the creek. Historical flood levels were available at 2 locations within the catchment however no recorded streamflows were available.

Rainfall

Rainfall occurred over a two day period commencing on 11 December 1991. **Figure 5.4: Rainfall Distribution - December 1991 Storm** presents the spatial distribution across the Bundamba Creek Catchment. This spatial distribution was taken directly from the Bundamba Creek Flood Study (CMPS&F 1996) and was calculated using a regression analysis of surrounding pluviographs and rainfall stations.

Rainfall values increased in a northerly direction with the highest rainfalls being recorded in the lower catchment. The total 2 day rainfall ranged from 260 mm to 288 mm. Pluviographs used in the hydrologic model are presented in **Figure 5.5: Representative Pluviographs - December 1991 Storm.**

Rainfall Losses

The losses used are given in **Table 5.4: Rainfall Losses - December 1991 Calibration.**

Table 5.4 - Rainfall Losses - December 1991 Calibration

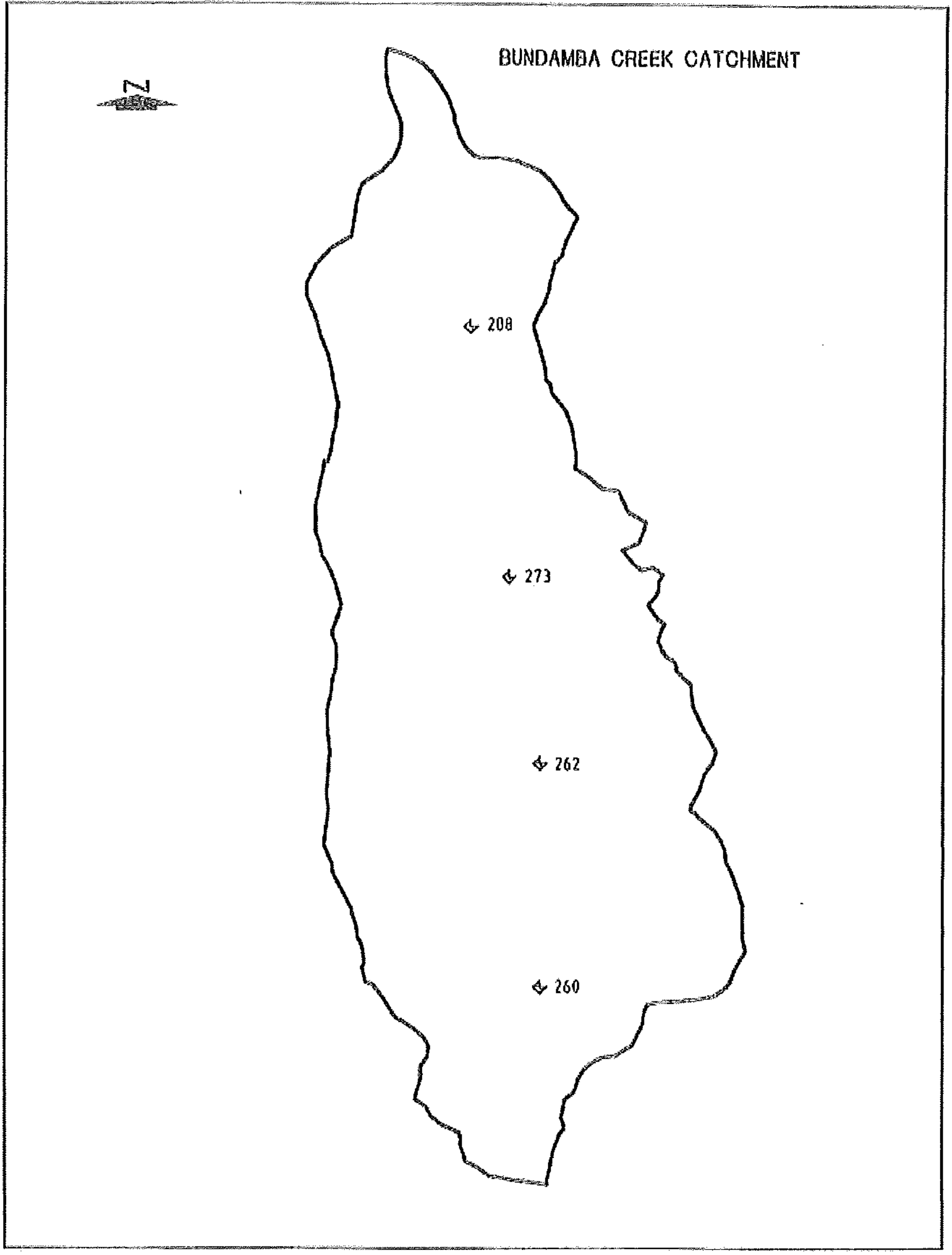
Sub-Catchment	Initial Loss (mm)	Continuing Loss (mm/hr)
Bundamba	100	2.5

Catchment Storage

To achieve a good calibration to the 1991 flood data, especially against the general shape of recorded stage hydrographs using both RAFTS and MIKE11 interactively, a PERN value of 0.1 was used for the pervious areas of the catchment and a PERN value of 0.03 for impervious areas.

SINCLAIR KNIGHT MERZ

FIGURE 5.4
RAINFALL DISTRIBUTION DECEMBER 1991 STORM



LEGEND

260 RAINFALL (mm)

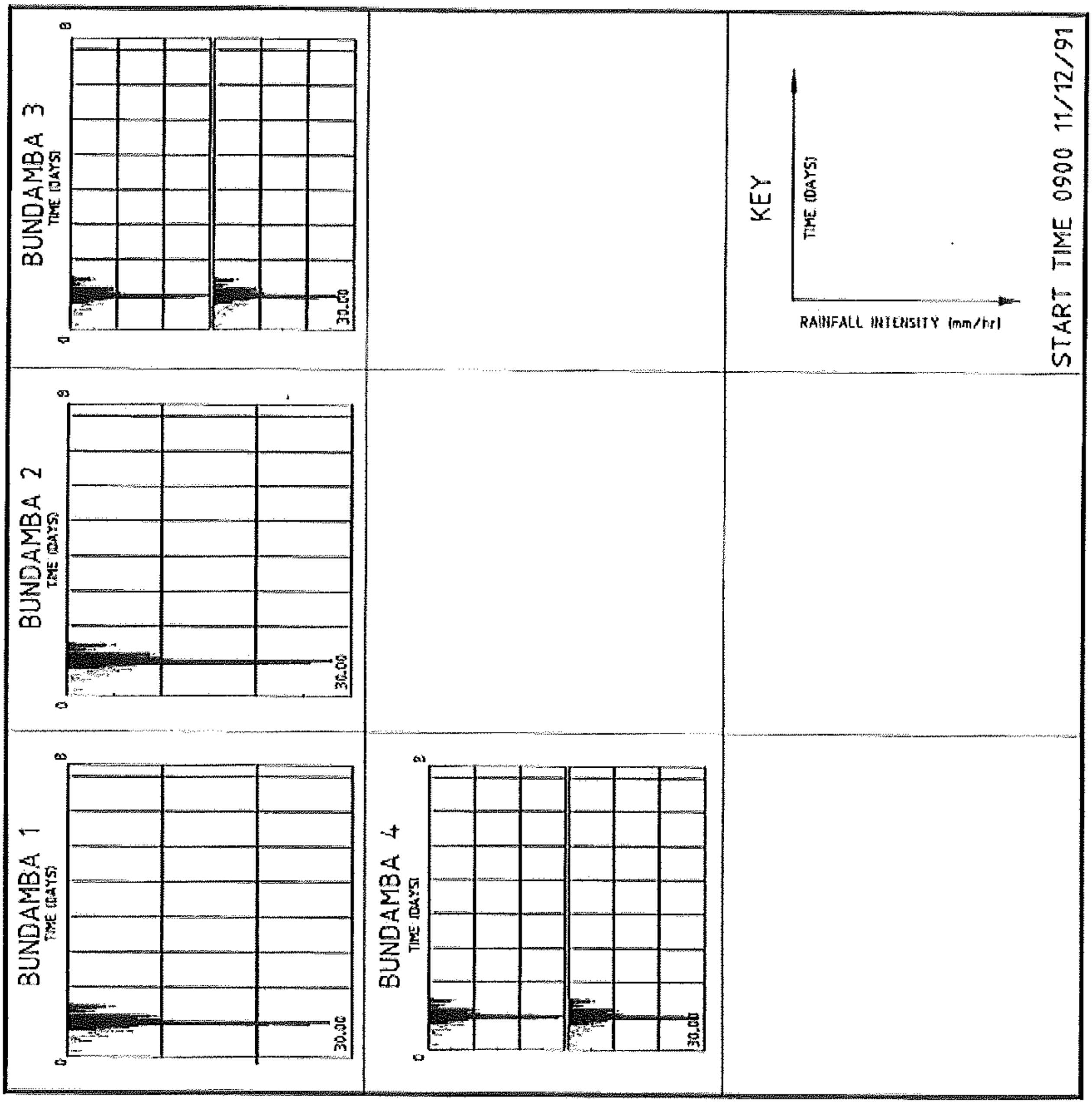
0 1 2 3 4 5 km

FILE NAME: 04390-20 DISK N°: U:\FWUD JOB N°: RE04390 DATE: 09-03-95
PLOT SCALE: 1=100

SINCLAIR KNIGHT MERZ

FIGURE 5.5

REPRESENTATIVE PLUVIOGRAPHS DECEMBER 1991 STORM



FILE NAME: 04390-21 DISK Nº: INREED JOB Nº: RE04390 DATE: 7.9.99

Channel Routing

A simple lag time assigned to each RAFTS link was generally found to reproduce the channel routing behaviour as recorded by the available stream gauges.

On this basis, link lag times were adjusted to match the recorded timing of hydrographs.

Recorded and Predicted Hydrographs

No recorded streamflow hydrographs were available for the Bundamba Creek Catchment, however using the recorded stage hydrograph and the MIKE11 hydraulic model, rating curves at Brisbane Road Flood alert gauge and Blackstone Road flood alert gauge were derived. These derived, recorded streamflow hydrographs and the predicted hydrographs are presented in **Appendix C (Figure C-1a)** and a summary of the results is presented in **Table 5.5: RAFTS Calibration – December 1991 Flood.**

Predicted peak discharges within the coverage of the MIKE11 model (ie. at Brisbane Road and Blackstone Road) are within six to eight percent of recorded peaks (derived).

Table 5.5: RAFTS Calibration - December 1991 Flood

Number	Stream	Site	Peak Discharge (m^3/s) Recorded	Predicted	Diff(%)
Bundamba Ck					
143982	Bundamba Ck	Brisbane Rd	370	374	+1
143919	Bundamba Ck	Blackstone Rd	353	379	+7.4

Note 1. Primary stream gauges are shaded.

5.6 RAFTS Calibration - January 1974 Flood

The January 1974 flood was the first event used in the calibration process for the full Brisbane River Catchment and is by far the largest of the floods considered. A significant amount of historical data is available for calibration, including rainfalls, streamflows and flood levels in the Brisbane River, Bremer River, Bundamba Creek and some of the other tributaries.

The 1974 flood occurred prior to construction of Wivenhoe Dam and is thus representative of pre-Wivenhoe Dam conditions.

Rainfall

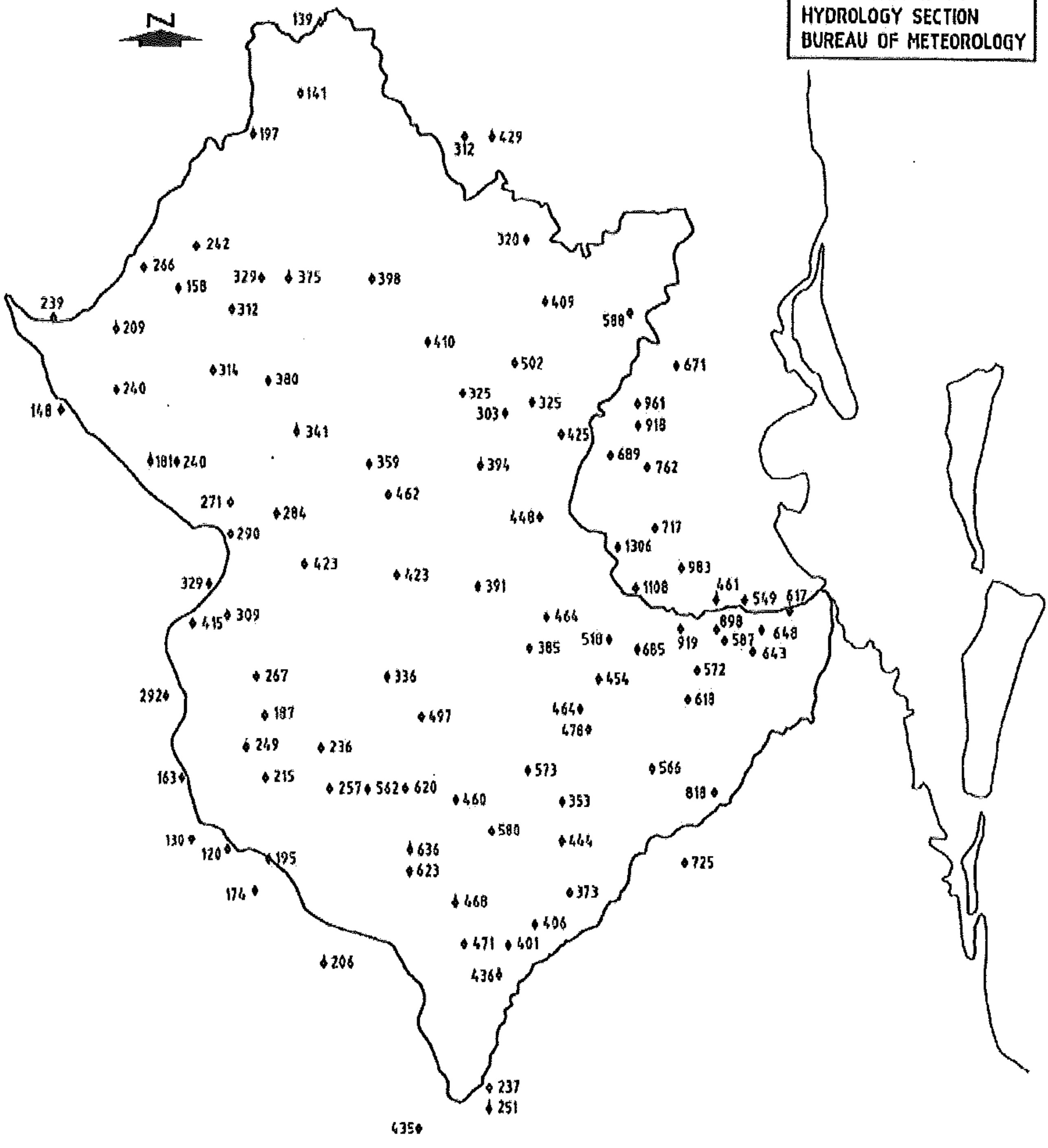
Rainfall occurred over a four day period commencing on midday 24 January 1974. **Figure 5.6: Rainfall Distribution - January 1974 Storm** presents the spatial distribution of rainfall across the Brisbane River catchment.

FIGURE 5.6

IPSWICH RIVERS FLOOD STUDY
RAINFALL DISTRIBUTION
- JANUARY 1974 STORM

SINCLAIR KNIGHT MERZ

DATA COMPILED BY
HYDROLOGY SECTION
BUREAU OF METEOROLOGY



STORM DURATION - 9am 24/01/74 TO 9am 28/01/74

LEGEND

♦ 70 RAINFALL (mm)

0 10 20 30 40 50 km

FILE NAME: 04390-11 DISK N°: U:\FWUD JOB N°: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1000(A4)

Rainfall tended to increase in an easterly direction, with the highest values being recorded at stations along the D'Aguilar Range and further south at Mount Glorious and Mount Nebo. Total four day rainfall ranged from 120 mm to 1 306 mm. Selected pluviograph patterns are shown on **Figure 5.7: Representative Pluviographs - January 1974 Storm.** Peak rainfall intensities tended to occur on 26 January. The Brisbane and Ipswich metropolitan areas recorded a sequence of three storms, the first and largest burst occurred on 25 January.

Rainfall Losses

The losses used to reproduce the rising limb and total volume of the recorded hydrograph at key stream gauges are given in **Table 5.6: Rainfall Losses - January 1974 Calibration.**

Table 5.6 - Rainfall Losses - January 1974 Calibration

Sub-Catchment	Initial Loss (mm)	Continuing Loss (mm/hr)
Upper Brisbane	0	2.5
Somerset	0	2.5
Wivenhoe	0	2.5
Lockyer	0	2.5
Bremer / Bundamba Creek	0	0
Lower Brisbane	0	2.5

Catchment Storage

By calibration to the 1974 flood data, especially against the general shape of recorded hydrographs, the following PERN values were applied:

- PERN equal to 0.11 - was used for Wivenhoe and Upper Brisbane sub-catchments.
- PERN generally equal to 0.05 - was used for Somerset, Lockyer, Bremer and Lower Brisbane sub-catchments.

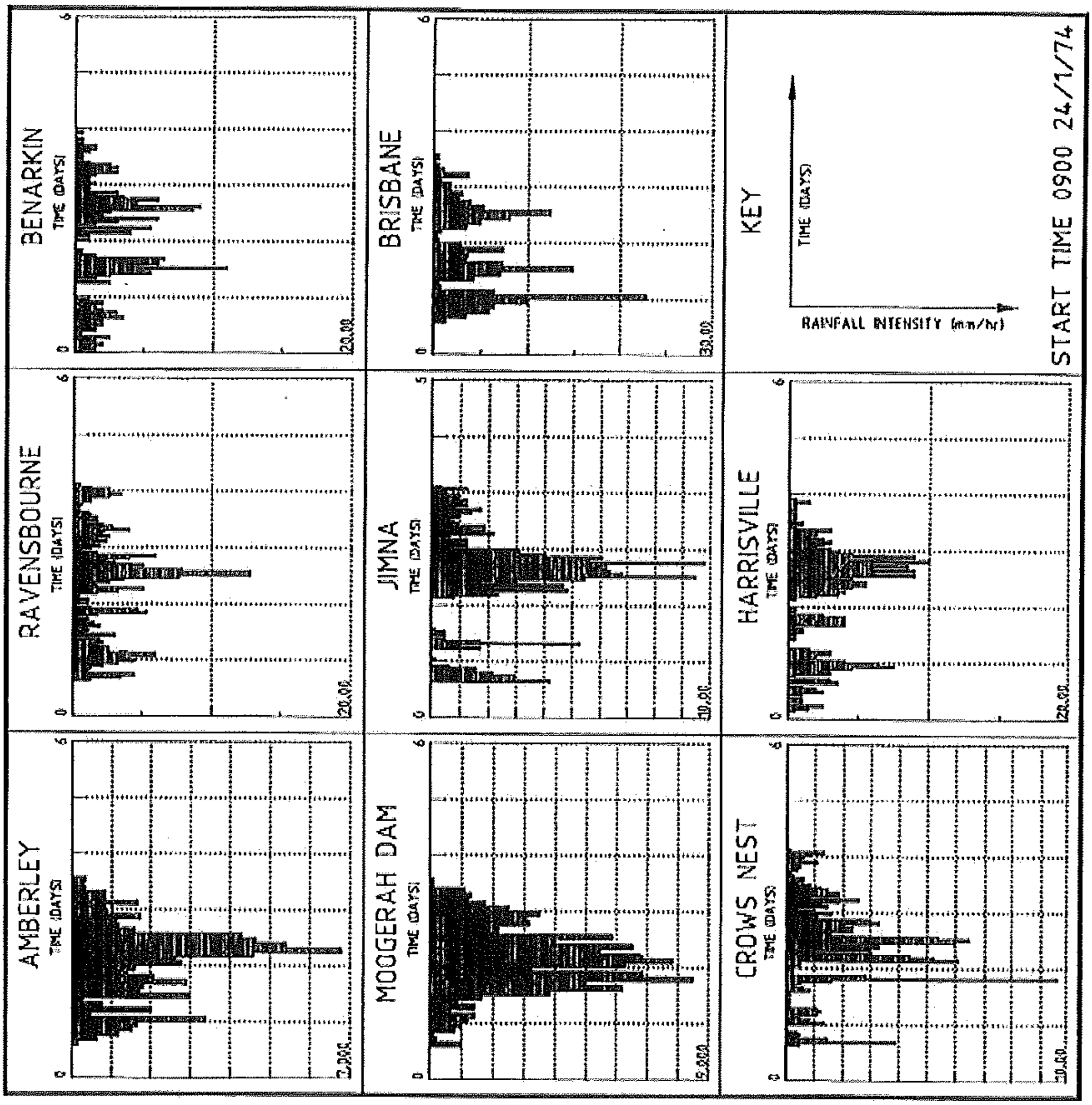
Channel Routing

A simple lag time assigned to each RAFTS link was found generally to reproduce the channel routing behaviour as recorded by the available stream gauges. For example, the Brisbane River stream gauge data at Savages Crossing and Mt Crosby shows no attenuation of peak discharge. This trend was also the case between the Moggill and Jindalee gauge sites.

On this basis, link lag times were adjusted to match the recorded timing of hydrographs, except in Bundamba Creek, where link times had already been established due to the calibration of the December 1991 flood event. Hydrograph attenuation due to local storage effects was found to be significant at the following three key sites:

SINCLAIR KNIGHT MERZ

FIGURE 5.7
IPSWICH RIVERS FLOOD STUDY REPRESENTATIVE PLUVIOGRAPHS - JANUARY 1974 STORM



FILE NAME: 04390-12 DISK N°: I.NREED JOB N°: RE04390 DATE: 7.9.99 PLOT SCALE: 1:30(A4)

- **Lowood** - Lockyer Creek enters the Brisbane River upstream of Lowood. The lower reaches of Lockyer Creek are low lying floodplains subject to extensive inundation during major floods. Thus, the Lockyer Creek confluence represents a large temporary flood storage and its ponding effect is controlled by Brisbane River backwater.

- **Moggill** - The Bremer River enters the Brisbane River upstream of the Moggill gauge. On a similar basis as the Lockyer Creek - Brisbane River confluence, a significant amount of temporary flood storage is available in the lower Bremer River which is regulated by local backwater conditions from the Brisbane River.

- **Harrisville** - The Warrill Creek floodplain near Harrisville has substantial storage routing effects, based on recorded hydrographs in this area.

Channel storage effects at the above locations were modelled by basin nodes.

In addition, storage effects due to backwater from the Brisbane River were generally evident through the lower reaches of Bremer River. This became obvious after performing consistency checks between the RAFTS and MIKE11 model. Therefore a basin node was also created in the RAFTS model at David Trumpy Bridge on Bremer River to simulate this effect.

A stage-storage-discharge relationship was derived at each storage, based on achieving a match against predicted and recorded downstream hydrographs. The storage relationships are shown as:

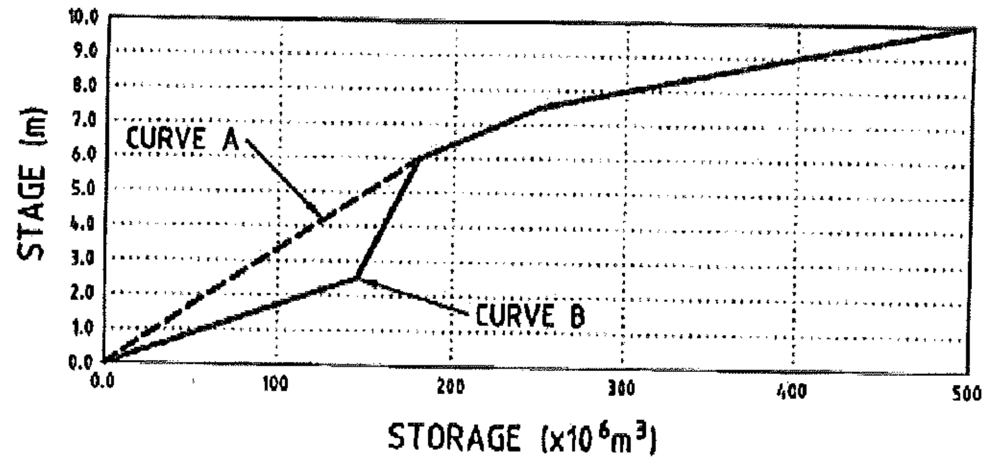
- **Figure 5.8: Channel Storage Curves at Lowood**
- **Figure 5.9: Channel Storage Curves at Moggill**
- **Figure 5.10: Channel Storage Curves at David Trumpy**
- **Figure 5.11: Channel Storage Curves at Harrisville**

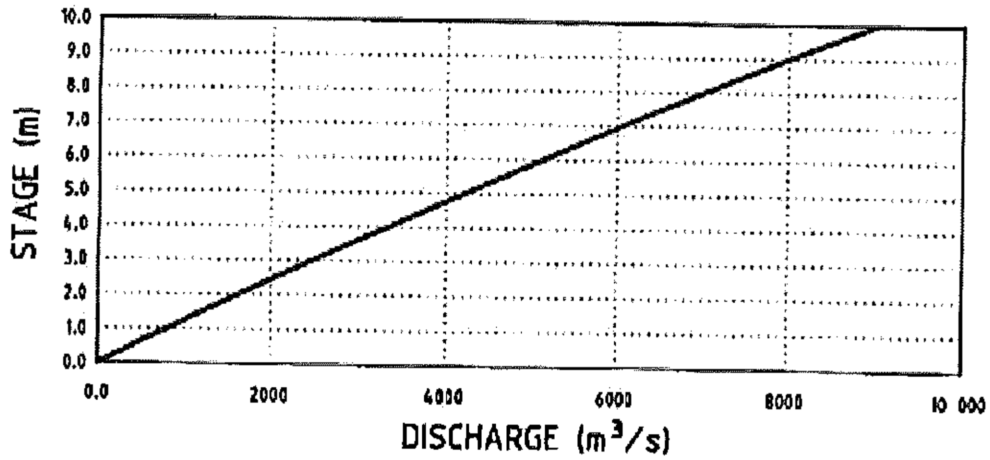
Two separate storage curves were created at Lowood and Moggill to adequately model both the January 1974 flood and the other smaller floods (1983, 1989 and 1996). Storage Curve A (presented in **Figure 5.8** and **Figure 5.9**) gave the best fit against recorded stream gauge data for the January 1974 flood. While it is evident that storage volume cannot physically vary at one location it should be remembered that storage in RAFTS is only a conceptual storage. These conceptual storages will vary according to volume and relative timing of flooding. As RAFTS is a hydrological model, it cannot directly model hydraulic interaction at stream confluences or stream effects, hence conceptual storages need to be included for calibration purposes. These conceptual storages are derived in conjunction with the Mike11 hydraulic model where possible, to achieve consistency between discharge hydrographs.

SINCLAIR KNIGHT MERZ

FIGURE 5.8

IPSWICH RIVERS FLOOD STUDY
CHANNEL STORAGE CURVES AT LOWOOD



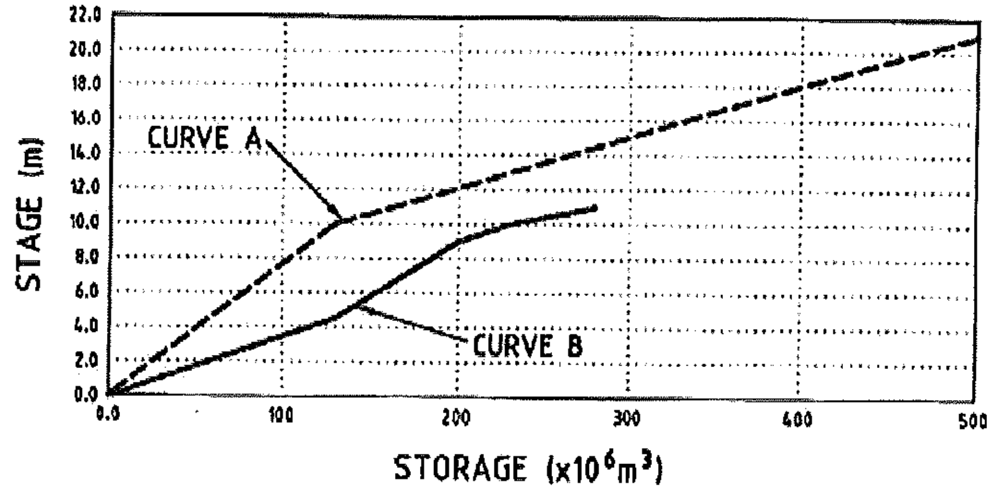


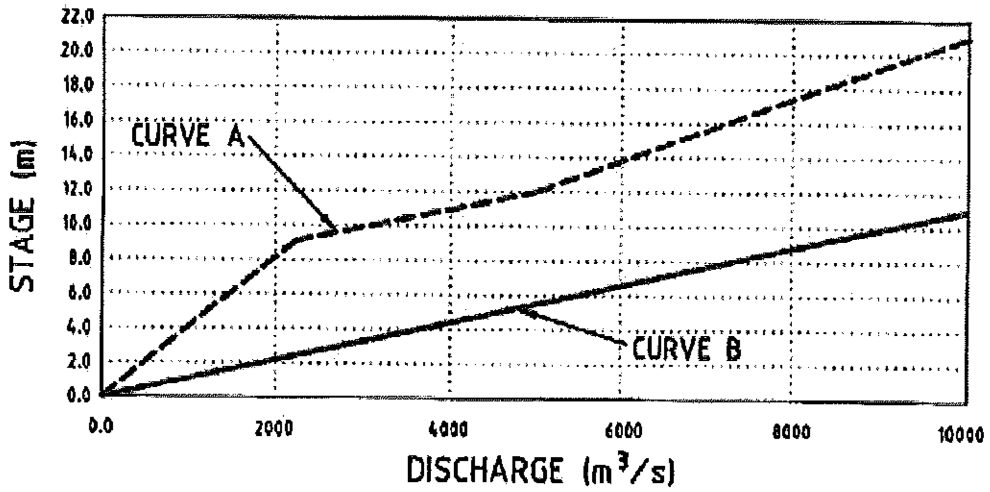
FILE NAME: 04390-13 JOB No: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1(A4)

SINCLAIR KNIGHT MERZ

FIGURE 5.9

IPSWICH RIVERS FLOOD STUDY
CHANNEL STORAGE CURVES AT MOGGILL



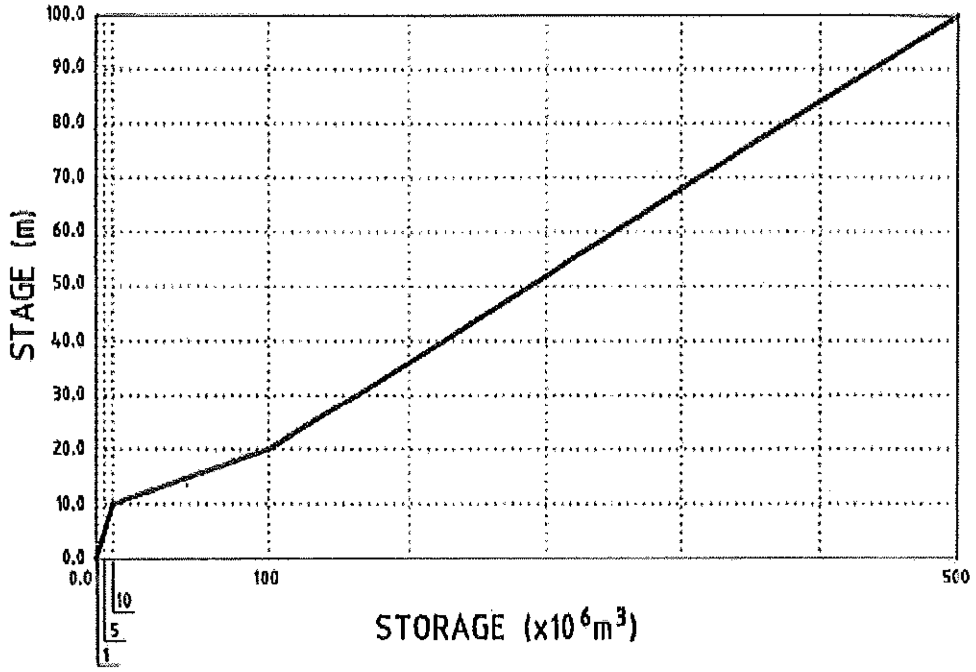


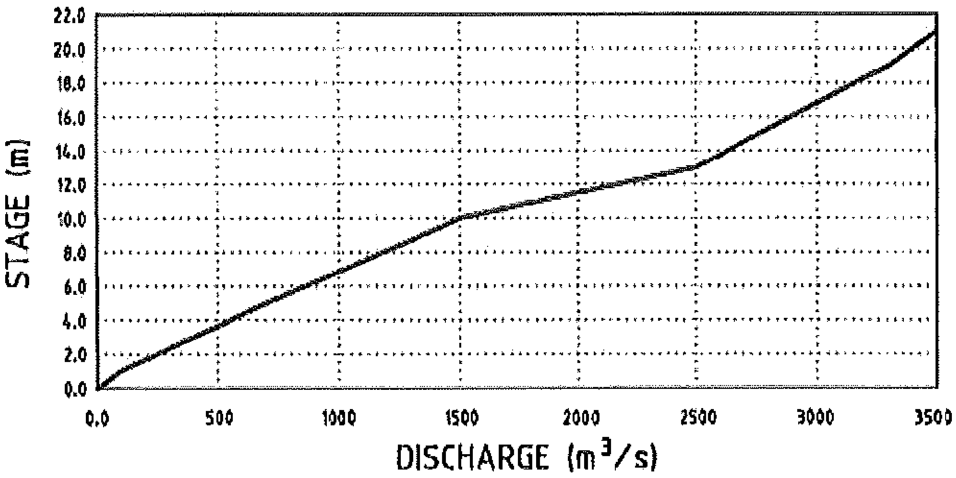
FILE NAME: 04390-13 DISK Nº: IA:\PWUD JOB Nº: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1(A4)

SINCLAIR KNIGHT MERZ

FIGURE 5.10

IPSWICH RIVERS FLOOD STUDY
CHANNEL STORAGE CURVES AT DAVID TRUMPY

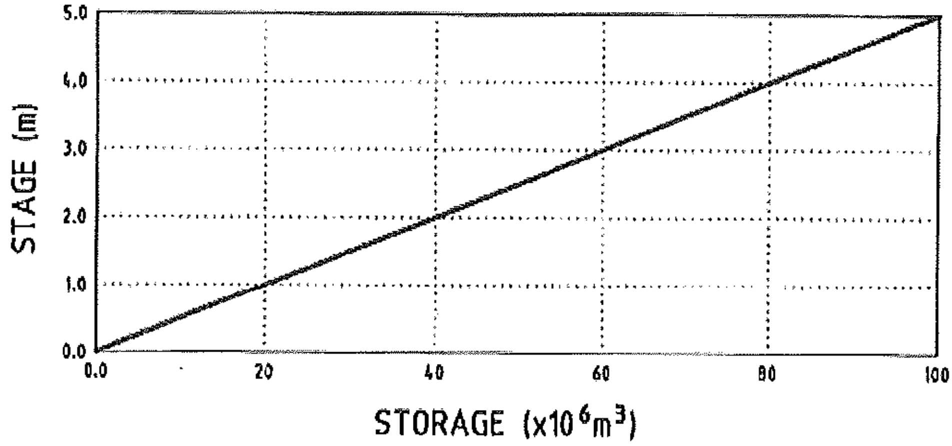


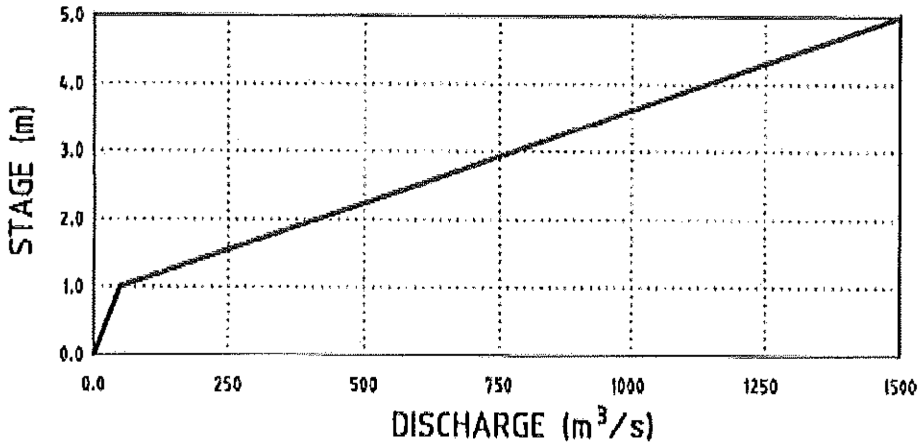


FILE NAME: 04390-13 DISK Nº: USFWUD JOB Nº: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1(A4)

FIGURE 5.11

IPSWICH RIVERS FLOOD STUDY
CHANNEL STORAGE CURVES AT HARRISVILLE





Recorded and Predicted Hydrographs
Plots of recorded and RAFTS predicted hydrographs for the January 1974 calibration are compiled in **Appendix C (Figure C-2a to C-2d)**. A summary is given in **Table 5.7: RAFTS Calibration - January 1974 Flood.**

Predicted peak discharges within the coverage of the MIKE11 model (ie. at Moggill, Jindalee and Port Office) are within 1 to 4 percent of recorded peaks. RAFTS estimated hydrograph volumes are 2 to 18 percent below measured volumes at Moggill and Jindalee. Part of this volume mismatch can be attributed to inconsistently high flows recorded at Moggill after the hydrograph recession and, similarly, high flows at Jindalee prior to the start of the hydrograph rising limb. At Port Office gauge, the predicted and measured flood volume are within 2 percent.

At other key sites in the Brisbane Valley, predicted peak discharges are within 0 to 13 percent of gauged discharges, except for Lockyer Creek at Lyons Bridge, Bremer River at David Trumpy Bridge and Warrill Creek at Amberley. The Lockyer Creek and Bremer River gauges are subject to backwater effects from Brisbane River.

Table 5.7: RAFTS Calibration - January 1974 Flood

Number	Stream	Site	Peak Discharge (m^3/s)			Discharge Volume (GL)			Comments
			Recorded	Predicted	Diff(%)	Recorded	Predicted	Diff(%)	
Upper Brisbane									
143015	Cooyar Ck	Damsite	967	585	-40	105	94	-10	
143007	Brisbane Rv	Linville	2 100	1 912	-9	181	220	+22	
143010	Emu Ck	Boat Mtn	1 054	882	-16	151	131	-13	
143009	Brisbane Rv	Gregors	3 750	3 829	+2	651	556	-15	
Somerset & Wivenhoe									
143305	Stanley Rv	Somerset Dam	3 587	3 119	-13	591	465	-21	
143008	Brisbane Rv	Middle Ck	4 813	5 429	+13	1 055	1 054	0	
143901	Stanley Rv	Woodford	1 111	1 332	+20	186	148	-20	
143303	Stanley Rv	Peachester	360	500	+39	77	56	-27	
143013	Cressbrook	Damsite	202	410	+103	33	48	+45	
Lockyer									
143203	Lockyer Ck	Helidon	1 308	858	-34	108	60	-44	
143210A	Lockyer Ck	Lyons Bridge	2 650	3 750	+42	492	475	-3	Backwater effect at gauge
143905	Lockyer Ck	Glenore Grove	3 900	3 466	-11	395	398	0	
143904	Lockyer Ck	Gatton	2 120	2 400	+13	132	200	+52	
143907	Brisbane Rv	Lowood	7 397	7 471	+1	1 891	1 743	-8	
Bremer & Lower Brisbane									
143001	Brisbane Rv	Savages Cross	7 340	7 487	+2	2 031	1 836	-10	
143003	Brisbane Rv	Mt Crosby	7 456	7 503	0	2 185	1 980	-9	
143110	Bremer Rv	Adams Bridge	349	531	+52	46	65	+41	
143108	Warrill Ck	Amberley	1 576	2 132	+35	294	386	+31	
143113	Purga Ck	Loamside	400	841	+110	55	70	+27	Poor rating at high flows
143019	Oxley Ck	Beatty Rd	985	966	-2	98	85	-13	
143911	Bremer Rv	David Trumpy	4 050	3323	-18	994	754	-24	Backwater effect at gauge
143915	Brisbane Rv	Moggill	9 346	4063	-11	3 472	2823	-19	Gauge flow high at end
143982	Brisbane Rv	Jindalee	9 493	9434	-1	3 587	2966	-17	Gauge flow high at start
143910	Brisbane Rv	Port Office	9 800	9444	-4	3 343	3118	-7	

Note: 1. Primary stream gauges are shaded.

5.7 RAFTS Calibration - June 1983 Flood

The June 1983 flood was a significant flood in the Upper Brisbane and Wivenhoe parts of the Brisbane Valley. Wivenhoe Dam was under construction and four of the five spillway monoliths were built to final crest level. The flood occurred prior to the installation of spillway gates and thus outflow from the dam was unregulated.

The 1983 flood data represents a transition between pre-Wivenhoe Dam and post-Wivenhoe Dam conditions.

Rainfall

Rainfall occurred over a period of three days commencing 20 June 1983. The spatial distribution of rainfall within the Brisbane River Catchment is presented in **Figure 5.12: Rainfall Distribution - June 1983 Storm.** Rainfalls varied from about 40 mm to 240 mm.

As shown in **Figure 5.13: Representative Pluviographs - June 1983 Storm**, two rainfall peaks occurred with the latter burst recorded on the morning of 22 June generally being dominant.

Rainfall Losses

The losses applied during the June 1983 flood calibration are given in **Table 5.8: Rainfall Losses - June 1983** Calibration.

Table 5.8: Rainfall Losses - June 1983 Calibration

Sub-catchment	Initial Loss (mm)	Continuing Loss (mm/hr)
Upper Brisbane	0	2.5
Somerset	0	1.5
Wivenhoe	0	2.5
Lockyer	0	2.5
Bremer	0	0.4
Lower Brisbane	0	2.5

Catchment Storage

A PERN coefficient of 0.05 was applied to the majority of the catchment.

Channel Routing

Link lag times used in the 1974 calibration were used except for upstream of the partially constructed Wivenhoe Dam. Faster travel times were used in the drowned reach of the Brisbane River from Somerset Dam to Wivenhoe Dam (Node WIV12 to WIV-OUT) to account for flood wave celerity effects.

At the channel storage nodes assigned at David Trumpy and Harrisville, the storage curves used for the January 1974 flood calibration were applied. At Lowood and Moggill a different relationship was applied. This is shown as Storage Curve B in **Figure 5.8** and **Figure 5.9**.

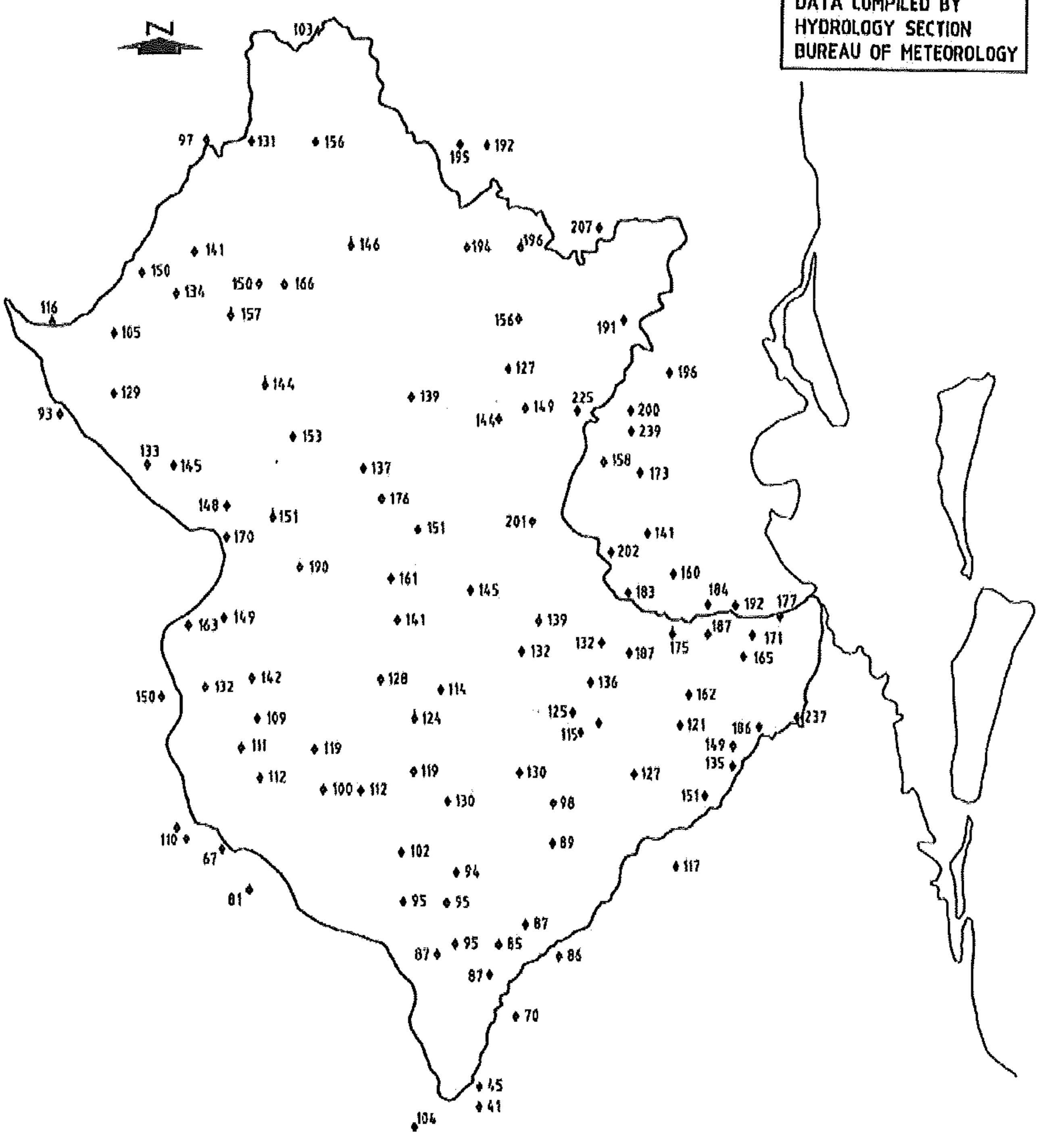
Recorded and Predicted Hydrographs

Plots of recorded and RAFTS predicted hydrographs for the June 1983 calibration are compiled in **Appendix C (Figure C-3a** to **C-3c)** and summarised in **Table 5.9: RAFTS Calibration - June 1983 Flood.**

FIGURE 5.12

IPSWICH RIVERS FLOOD STUDY RAINFALL DISTRIBUTION - JUNE 1983 STORM

DATA COMPILED BY
HYDROLOGY SECTION
BUREAU OF METEOROLOGY



STORM DURATION - 9am 20/06/83 TO 9am 23/06/83

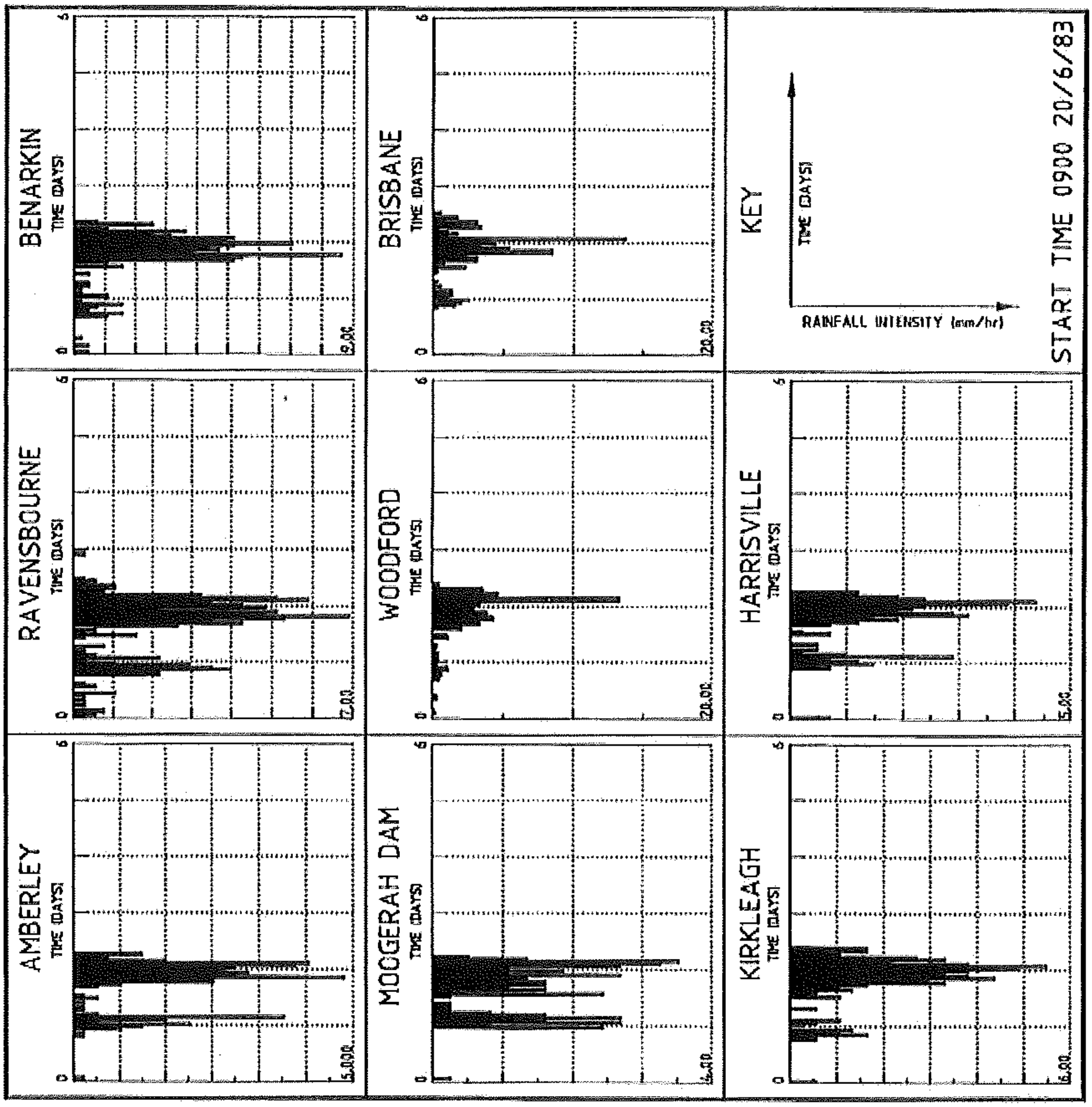
LEGEND

♦ 70 RAINFALL (mm)

0 10 20 30 40 50 km

SINCLAIR KNIGHT MERZ

FIGURE 5.13
IPSWICH RIVERS FLOOD STUDY
REPRESENTATIVE PLUVIOGRAPHS - JUNE 1983 STORM



FILE NAME: 04390-15 DISK N°: I:\REED JOB N°: RE04390 DATE: 7.5.99 PLOT SCALE: 1:80(A4)

The match between predicted and recorded flows at key sites are generally within acceptable limits. Flows based on the Brisbane River gauge at Moggill are substantially lower than RAFTS predicted discharge. This trend was also present in the analysis of the late April 1989 event (refer to Section 5.8). This flood of the lower Brisbane River was of similar magnitude and less than 2 000 m^3/s.

Also the Moggill hydrograph volume based on the gauge data is substantially less than the volume recorded upstream at Savages Creek. On this basis, it is suggested that the Moggill rating curve be adjusted for moderate floods (less than 2 000 m^3/s). There also may be a need to have a rating curve dependent on downstream tide levels at this site.

Table 5.9: RAFTS Calibration - June 1983 Flood

Number	Stream	Site	Peak Discharge (m^3/s)			Discharge Volume (GL)			Comments
			Recorded	Predicted	Diff(%)	Recorded	Predicted	Diff(%)	
Upper Brisbane									
143015	Cooyar Ck	Damsite	707	1 159	+64	51	70	+37	
143007	Brisbane Rv	Linville	2 090	2 204	+5	148	146	-1	
143010	Emu Ck	Boat Mtn	885	1 188	+34	47	75	+60	
143009	Brisbane Rv	Gregors Ck	3 850	4 118	+7	332	309	-7	
Somerset & Wivenhoe									
143305	Stanley Rv	Somerset Dam	2 238	2 316	+4	260	177	-32	
143036	Brisbane Rv	Wivenhoe Dam	5 900	5 849	-1	776	739	-5	Synthetic gauged hydrograph
143303	Stanley Rv	Peachester	310	362	+17	27	16	-41	
Lockyer									
143203	Lockyer Ck	Helidon	619	540	-13	41	29	-29	
143212	Tenthill Ck	Tenthill	183	345	+89	15	21	+40	
143210A	Lockyer Ck	Lyons Bridge	2 280	2 370	+4	166	156	-6	Backwater effect at gauge
143905	Lockyer Ck	Glenore Grove	2 100	2 261	+8	218	126	-42	
Bremer & Lower Brisbane									
143001	Brisbane Rv	Savages Cross	1 641	1 513	-8	721	614	-15	
143110	Bremer Rv	Adams Bridge	132	128	-3	10	12	+20	
143107	Bremer Rv	Walloon	387	830	+114	33	72	+118	
143108	Warrill Ck	Amberley	383	365	-5	50	68	+36	
143113	Purga Ck	Loamside	141	366	+160	12	19	+58	
143911	Bremer Rv	David Trumpy	2 045	1246	-39	110	164	+39	Gauge record incomplete
143915	Brisbane Rv	Moggill	1 457	1943	+33	450	832	+85	Recorded volume < Savages Crossing

Note: 1. Primary streamgauges are shaded.

5.8 RAFTS Calibration - Late April 1989 Flood

The late April 1989 flood was a significant event in the Upper Brisbane and Somerset parts of the catchment. It occurred about three weeks after the incidence of a flood of similar magnitude in early April 1989.

The flood regulation function of Wivenhoe Dam was in full operation during the 1989 floods as indicated by the dam outflow hydrographs presented in **Figure 5.2: Wivenhoe Dam Discharges.** Releases from Wivenhoe Dam during the late 1989 flood continued for a period of four days after the cessation of dam inflows.

On this basis, the late April 1989 flood (in addition to the May 1996 calibration event) are representative of post-Wivenhoe Dam conditions.

Rainfall

As shown in **Figure 5.14: Rainfall Distribution - Late April 1989 Storm**, the highest rainfalls were recorded in the upper parts of the Somerset sub-catchment. Total rainfalls up to 355 mm were recorded over a three day period. In the Lockyer and Bremer areas of the catchment, rainfalls were substantially less and generally fell in the range of 50 to 100 mm.

Selected rainfall temporal patterns are presented in **Figure 5.15: Representative Pluviographs - Late April 1989 Storm.** All stations recorded a storm burst during mid April and at some locations including Ravensbourne, Moogerah Dam and Kirkleagh, this burst was preceded by a similar rainfall pattern on 25 April.

Rainfall Losses

Table 5.10: Rainfall Losses - Late April 1989 Calibration lists the initial and continuing losses applied in the hydrograph calibration.

Table 5.10: Rainfall Losses - Late April 1989 Calibration

Sub-catchment	Initial Loss (mm)	Continuing Loss (mm/hr)
Upper Brisbane	30	2.5
Somerset	30	0
Wivenhoe	30	2.5
Lockyer	30	2.5
Bremer / Bundamba Creek	0	0.4
Lower Brisbane	30	2.5

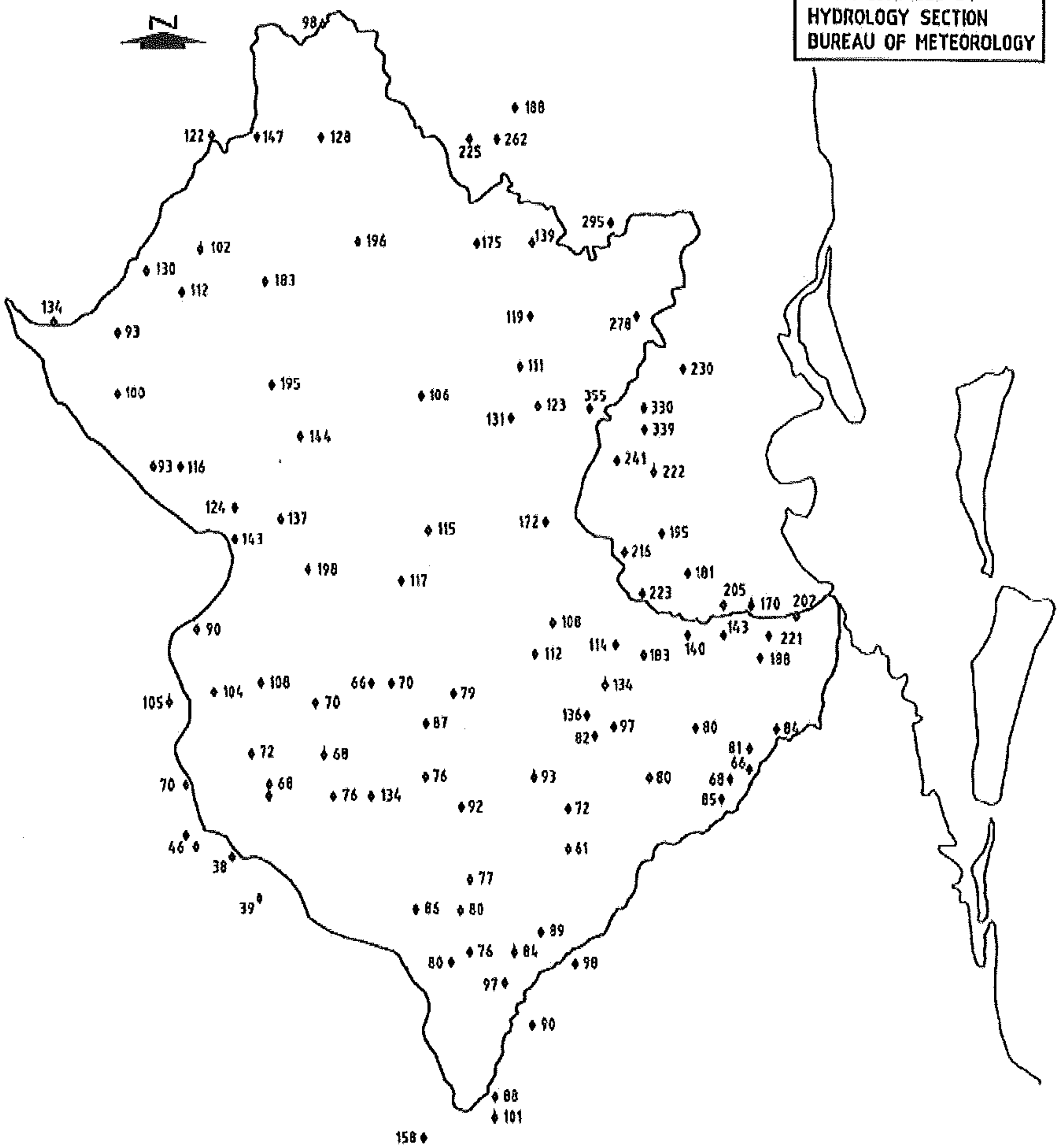
Catchment Storage

A PERN coefficient of 0.05 was generally applied across the catchment.

FIGURE 5.14

SINCLAIR KNIGHT MERZ

IPSWICH RIVERS FLOOD STUDY
RAINFALL DISTRIBUTION
- LATE APRIL 1989 STORM



STORM DURATION - 9am 24/04/89 TO 9am 27/04/89

LEGEND

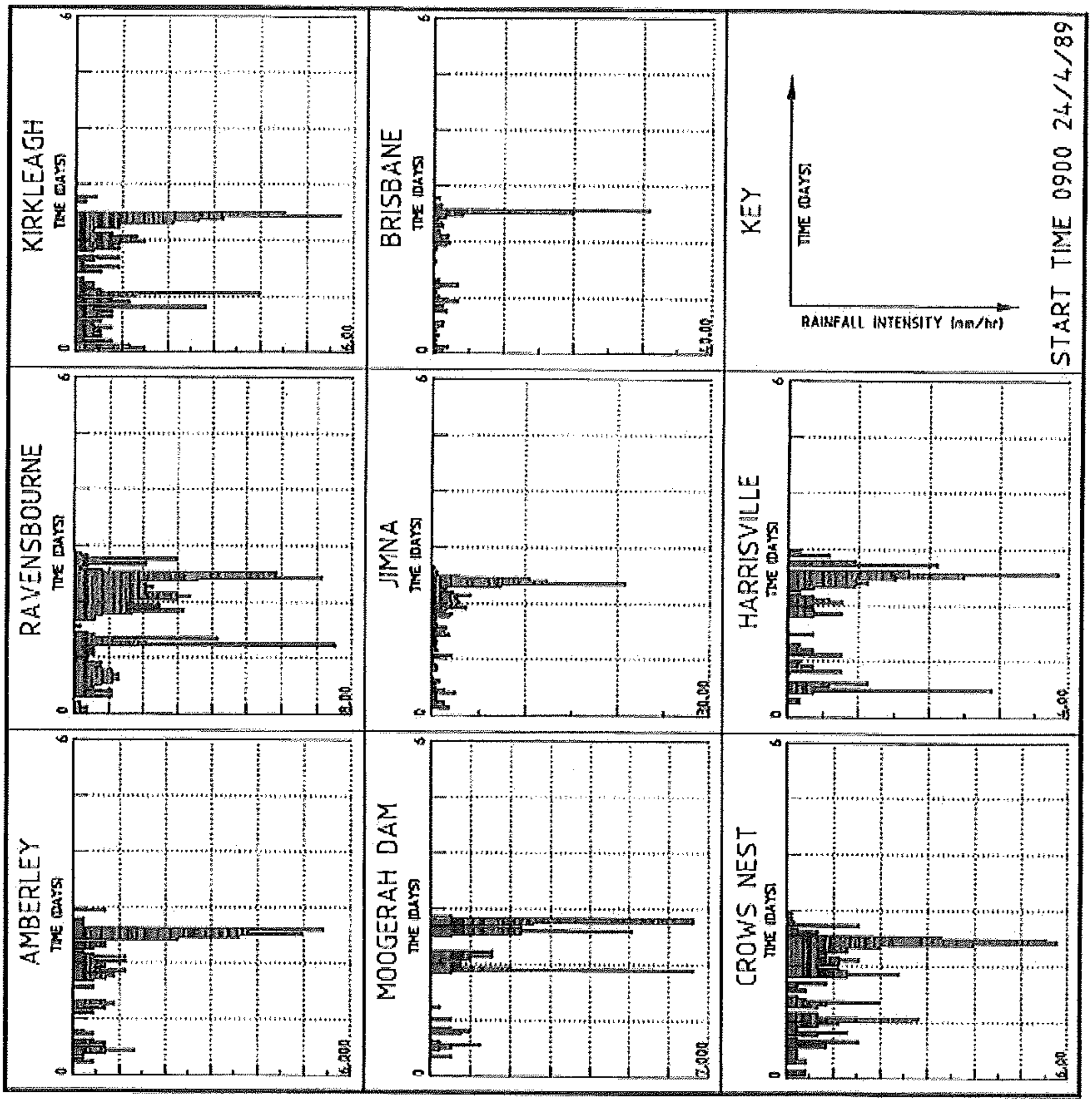
◆ 70 RAINFALL (mm)

0 10 20 30 40 50 km

FILE NAME: 04390-15 DISK N°: L:\FWUD JOB N°: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1000(A4)

SINCLAIR KNIGHT MERZ

FIGURE 5.15
IPSWICH RIVERS FLOOD STUDY
REPRESENTATIVE PLUVIOGRAPHS
- LATE APRIL 1989 STORM



Catchment Routing
The late April 1989 flood was the first event analysed that incorporated controlled flood regulation at Wivenhoe Dam.

Link lag times were a modified set of travel times used in the June 1983 flood when the dam was under construction. In the case of the late April 1989 flood calibration, travel times were reduced in the Brisbane River reach from the dam wall to the upstream extent of the Wivenhoe Dam storage (Node WIV7 to WIV-OUT).

During the calibration process, travel times were also reduced in the Brisbane River reach from Linville to Scrub Creek (Node GRE1 to GRE-OUT).

At the channel storage nodes assigned at Lowood, Moggill, David Trumpy and Harrisville, the storage curves used in the June 1983 flood calibration were used.

Recorded and Predicted Hydrographs
Plots of recorded and RAFTS predicted hydrographs for the late April 1989 calibration are presented in **Appendix C (Figure C-4a to C-4d)**. Further details are given in **Table 5.11: RAFTS Calibration - Late April 1989 Flood.**

Recorded and predicted discharge peaks at key sites are generally matched within about 15 percent.

The synthetic inflow hydrograph at Wivenhoe Dam has an unrealistic discharge 'spike' and this accounts for the discrepancy with the RAFTS peak discharge at this location.

Table 5.11: RAFTS Calibration - Late April 1989 Flood

Number	Stream	Site	Peak Discharge (m^3/s)			Discharge Volume (GL)			Comments
			Recorded	Predicted	Diff(%)	Recorded	Predicted	Diff(%)	
Upper Brisbane									
143015	Cooyar Ck	Damsite	436	648	+49	34	47	+38	
143007	Brisbane Rv	Linville	2 214	2 178	-2	116	128	+10	
143010	Emu Ck	Boat Mtn	610	612	0	39	45	+15	
143009	Brisbane Rv	Gregors Ck	3 250	3 457	+6	297	238	-20	Lag error in gauge
Somerset & Wivenhoe									
143305	Stanley Rv	Somerset Dam	3 639	2 620	-28	337	273	-19	
143036	Brisbane Rv	Wivenhoe Dam	9 632	4 760	-50	702	602	-14	Spike in synthetic hydrograph
143901	Stanley Rv	Woodford	642	1 089	+70	201	111	-45	
143303	Stanley Rv	Peachester	431	729	+69	34	53	+56	
Lockyer									
143203	Lockyer Ck	Helidon	499	184	-63	19	11	-42	
143212	Tenthill Ck	Tenthill	89	70	-17	15	7	-53	
143225	Laidley Ck	Showground	119	46	-61	16	4.3	-73	
143905	Lockyer Ck	Glenore Grove	422	409	-3	67	34	-49	
Bremer & Lower Brisbane									
143001	Brisbane Rv	Savages Cross	1 409	1 210	-14	816	753	-8	
143110	Bremer Rv	Adams Bridge	96	79	-18	6.3	9	+43	
143107	Bremer Rv	Walloon	259	521	+101	20	51	+155	
143108	Warrill Ck	Amberley	252	287	+14	41	61	+49	
143113	Purga Ck	Loamside	112	243	+117	11	14	+27	
143911	Bremer Rv	David Trumpy	773	698	-10	74	106	+43	Gauge record incomplete
143915	Brisbane Rv	Moggill	1 200	1213	+1	752	895	+19	

Note: 1. Primary streamgauges are shaded.

5.9 RAFTS Calibration - May 1996 Flood

The flood of May 1996 caused extensive flooding of rural areas throughout the Brisbane Valley, especially in the Laidley and Lockyer Creek areas. Significant flows were also recorded along the Bremer River and Warrill Creek and this caused moderate flooding at Ipswich. A full description of the meteorological and hydrologic aspects of the May 1996 flood has been prepared by the Bureau of Meteorology (BOM, 1996).

No dam releases during the May 1996 flood were reported at Somerset Dam or Wivenhoe Dam.

Rainfall

Rainfall associated with the May 1996 flood occurred over a period of several days. Eight day rainfall totals within the Brisbane Valley are shown in **Figure 5.16: Rainfall Distribution - May 1996 Storm.** Maximum rainfalls of in excess of 1 000 mm were recorded at Mount Glorious. As shown in **Figure 5.17: Representative Pluviographs - May 1996 Storm**, the rainfall pattern was multi-peaked with recorded intensities generally less than 4 mm/h with peaks of the order of 10 mm/h.

Rainfall Losses

Table 5.12: Rainfall Losses - May 1996 Calibration lists the rainfall losses assigned to each Brisbane River sub-catchment.

Table 5.12: Rainfall Losses - May 1996 Calibration

Sub-catchment	Initial Loss (mm)	Continuing Loss (mm/hr)
Upper Brisbane	160	2.5
Somerset	150	2.0
Wivenhoe	160	2.5
Lockyer	140	1.2
Bremer	100	1.1
Bundamba Creek	100	0.8
Lower Brisbane	100	1

Catchment Storage

A PERN coefficient of 0.05 was applied to the majority of the catchment.

Channel Routing

Link lag times within the RAFTS model and channel storage properties at Lowood, Moggill, David Trumpy, and Harrisville were identical to those used in the late April 1989 flood calibration.

Recorded and Predicted Hydrographs

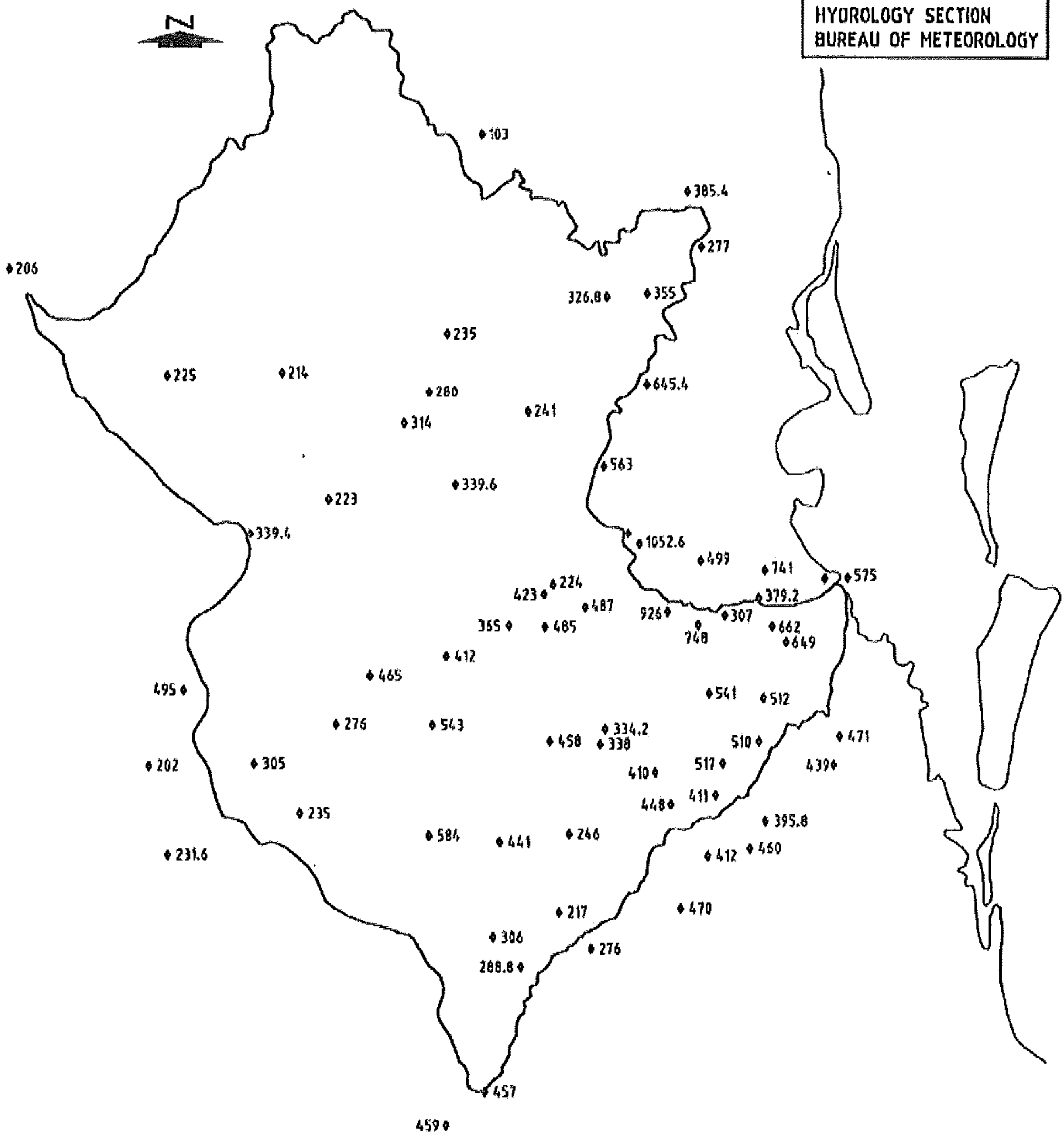
Plots of recorded and RAFTS predicted hydrographs for the May 1996 calibration are presented in **Appendix C (Figures C-5a to C-5d)**. Further summary information is compiled in **Table 5.13: RAFTS Calibration - May 1996 Flood**. For the lower reaches of the Brisbane River, peak discharges are predicted by RAFTS to within 6 percent of gauged flows.

SINCLAIR KNIGHT MERZ

FIGURE 5.16

IPSWICH RIVERS FLOOD STUDY
RAINFALL DISTRIBUTION
- MAY 1996 STORM

DATA COMPILED BY
HYDROLOGY SECTION
BUREAU OF METEOROLOGY



STORM DURATION - 9am 31/04/96 TO 9am 07/05/96

LEGEND

◆ 70 RAINFALL (mm)

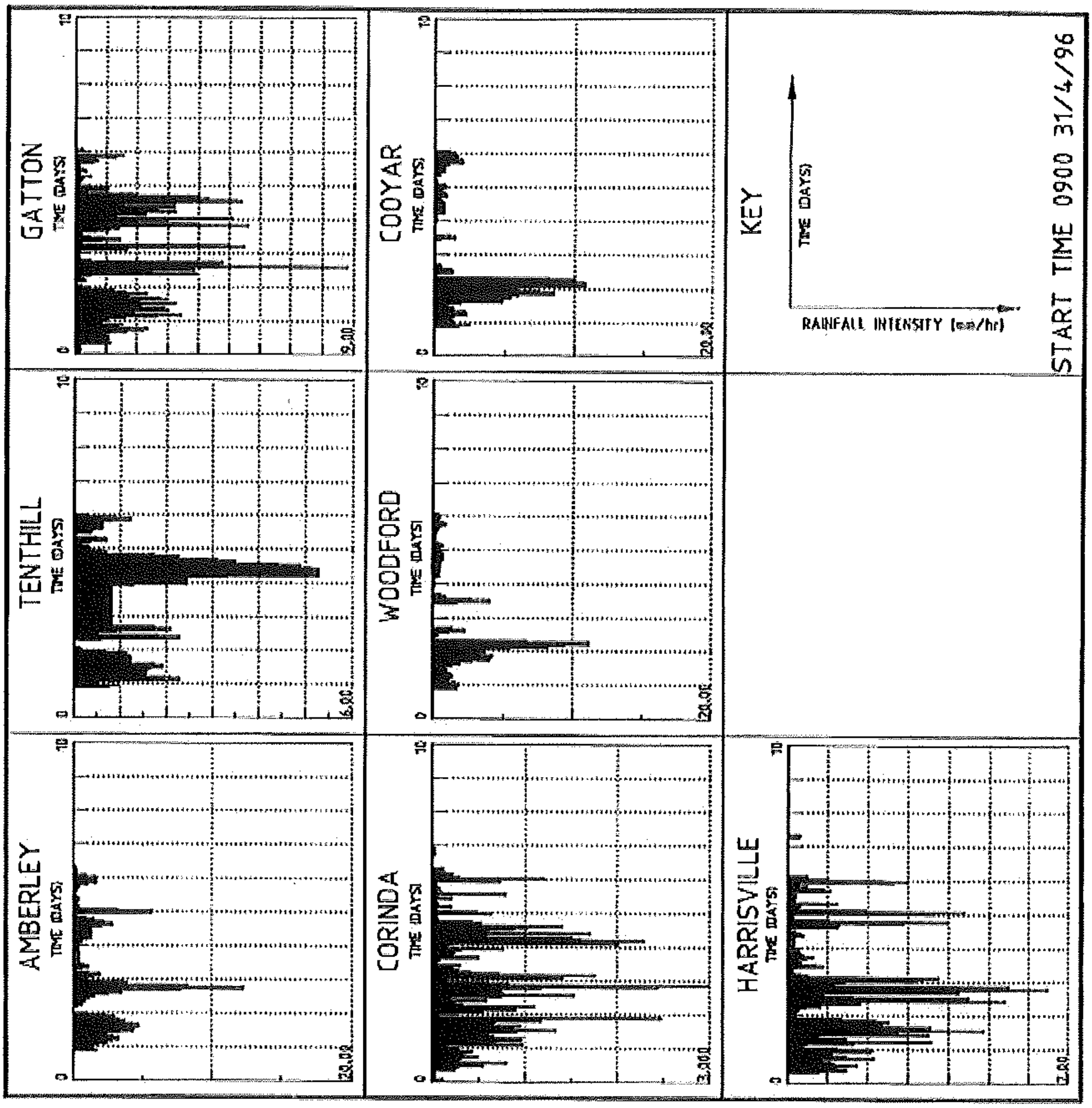
0 10 20 30 40 50 km

FILE NAME: 04390-18 DISK No: L:\FWUD JOB No: RE04390 DATE: 2-3-99 PLOT SCALE: 1:1000(A4)

SINCLAIR KNIGHT MERZ

FIGURE 5.17

IPSWICH RIVERS FLOOD STUDY REPRESENTATIVE PLUVIOGRAPHS - MAY 1996 STORM



FILE NAME: 04390-19 DISK N°: EVREED JOB N°: RE04390 DATE: 7.9.99 PLOT SCALE: 1:80(A4)

Table 5.13: RAFTS Calibration - May 1996 Flood

Number	Stream	Site	Peak Discharge (m^3/s)			Discharge Volume (GL)			Comments
			Gauged	Predicted	Diff(%)	Gauged	Predicted	Diff(%)	
Upper Brisbane									
143015	Cooyar Ck	Damsite	41	74	+80	9.3	6.4	-31	Relatively low flow
143007	Brisbane Rv	Linville	57	75	+32	17.4	6.9	-60	Relatively low flow
143010	Emu Ck	Boat Mtn	380	198	-49	39	18	-54	
143009	Brisbane Rv	Gregors Ck	479	340	-29	78	52	-32	
Somerset & Wivenhoe									
143036	Brisbane Rv	Wivenhoe Dam	2 386	2 644	+11	343	232	-32	
Lockyer									
143203	Lockyer Ck	Helidon	739	259	-65	93	34	-63	
143212	Tenthill Ck	Tenthill	628	592	-6	71	107	+51	
143225	Laidley Ck	Showground	540	485	-10	66	76	+15	
143907	Brisbane Rv	Lowood	2 020	2 088	+3	525	578	+10	
143905	Lockyer Ck	Glenore Grove	2 460	2 253	-8	475	410	-14	
Bremer & Lower Brisbane									
143001	Brisbane Rv	Savages Cross	2 011	2 102	+5	532	609	+14	
143110	Bremer Rv	Adams Bridge	225	210	-7	35	24	-31	
7020	Bremer Rv	Rosewood	781	828	+6	155	126	-19	
6572	Warrill Ck	Harrisville	376	344	-9	88	80	-9	
143107	Bremer Rv	Walloon	726	907	+25	127	140	+10	
143102	Warrill Ck	Kalbar	426	572	+34	52	56	+8	
143108	Warrill Ck	Amberley	402	425	+6	129	121	6	
143915	Brisbane Rv	Moggill	2 702	2021	+5	701	1099	+44	Record incomplete
143911	Bremer Rv	David Trumpy	1280	1622	+27	-	349	-	

Note: 1. Primary streamgauges are shaded.

5.10 Adopted RAFTS Model Parameters

RAFTS Storage

By a process of calibration against a series of historical floods, a set of RAFTS storage parameters were determined. These parameters tended to fall into two groups; pre-Wivenhoe Dam conditions prior to 1985 and post-Wivenhoe Dam conditions following completion of the dam.

Table 5.14: Summary of RAFTS Storage Parameters provides an overview of adopted storage properties.

Table 5.14: Summary of RAFTS Storage Parameters

Storage Type	Pre-Wivenhoe Dam Conditions	Post-Wivenhoe Dam Conditions
Catchment Storage	PERN = 0.05 except PERN = 0.11 for Wivenhoe and Upper Brisbane	PERN = generally 0.05
Channel Routing	Link times based on timing of recorded hydrographs Basin node storage at Lowood (storage curve A), Moggill and Harlaville as shown in Figures 5-6, 5-7 and 5-8	Link travel times as per Pre-Wivenhoe conditions, modified to account for Wivenhoe Dam drowned reach Basin node storage as per Pre-Wivenhoe conditions, except storage curve B used at Lowood.

Notes:

1. Pre-Wivenhoe conditions based on calibration against January 1974 flood and verified against June 1973 flood.
2. Post-Wivenhoe conditions based on calibration against late April 1989 and May 1996 floods.

The difference in model factors, such as faster link travel times upstream of the dam for post-Wivenhoe Dam conditions, can be directly attributed to the physical presence of the Wivenhoe Dam lake. Other factors, such as the adopted PERN coefficient in the Wivenhoe and Upper Brisbane areas, are due to the state of vegetative growth in the catchment at the time of flood.

As a check on the sensitivity of predicted hydrographs to assumptions on storage parameters, the January 1974 were re-run assuming post-Wivenhoe Dam storage conditions (except for link travel times). A PERN value of 0.05 was applied throughout the RAFTS model and storage curve A was used at the Lowood basin node.

Summary details at key gauges affected by this change are given in **Table 5.16: January 1974 Flood Analysis - Post Wivenhoe Storage.**

Table 5.16: January 1974 Flood Analysis - Post Wivenhoe Storage

Number	Stream	Site	Peak Discharge (m^3/s)		
			Recorded	Predicted	Diff (%)
January 1974 Flood					
143007	Brisbane Rv	Linville	2 100	2 430	+16
143009	Brisbane Rv	Gregors Ck	3 750	4 358	+14
143008	Brisbane Rv	Middle Ck	4 813	5 903	+23
143907	Brisbane Rv	Lowood	7 397	7 840	+6
143001	Brisbane Rv	Savages Cross	7 340	7 868	+7
143003	Brisbane Rv	Mt Crosby	7 450	7 874	+6
143915	Brisbane Rv	Moggill	9 346	10 220	+12
143910	Brisbane Rv	Port Office	9 800	10 247	+5

The reduced catchment storage within the Upper Brisbane and Wivenhoe areas tended to increase predicted discharge peaks compared to the calibrated values (refer to **Table 5.16** and **Table 5.7**). Towards the lower reaches of the Brisbane River, the difference between predicted and recorded peaks are less than 10 percent. The change in node storage properties at Lowood introduces a steeper hydrograph in the January 1974 flood.

Rainfall Losses
An overview of initial and continuing losses used in the RAFTS calibration and verification analysis is given in **Table 5.17: Summary of RAFTS Rainfall Losses.**

Table 5.17: Summary of RAFTS Rainfall Losses

Sub-catchment	December 1991	January 1974	June 1983	Late April 1989	May 1996
Upper Brisbane	NA	0 & 2.5	0 & 2.5	30 & 2.5	150 & 2.5
Somerset	NA	0 & 2.5	0 & 1.5	30 & 0	150 & 2.0
Wivenhoe	NA	0 & 2.5	0 & 2.5	30 & 2.5	150 & 2.5
Lockyer	NA	0 & 2.5	0 & 2.5	30 & 2.5	140 & 1.2
Bremer	NA	0 & 0	0 & 0	10 & 0	100 & 1.5
Bundamba	100 & 2.5	0 & 0	0 & 0	10 & 0	100 & 1.5
Lower Brisbane	NA	0 & 2.5	0 & 2.5	30 & 2/5	100 & 1.5

Note: 0 & 2.5 denotes 0 mm initial loss and 2.5 mm continuing loss.

The above losses fall in the expected range for South East Queensland. These loss rates will be considered when design event loss rates are selected. It is expected that the design event loss rates will fall within the bounds of the loss rates presented in **Table 5.17**.

6. Hydraulic Model

6.1 Overview

The overall purpose of any hydraulic modelling is to describe the movement or behaviour of floods as they pass through the channel system and associated floodplains. Flood levels, extent of inundation and flow velocities at various locations along the study reach are computed in the process.

In order for the model results to be reliable, it is necessary to calibrate and verify the hydraulic model. The calibration process involves the matching of calculated levels with recorded levels for as many recorded events as possible. Characteristics such as channel roughness parameters and appropriate model schematisation are derived in the calibration process.

The next major step after calibrating the model is to test or verify the model by using the model parameters derived during the calibration phase. This process is necessary in order to ensure that the model accurately describes the hydraulic behaviour of the channel system for both recorded events and design events.

The one-dimensional hydrodynamic model, MIKE11 developed by the Danish Hydraulic Institute was selected for the hydraulic analysis. HEC-RAS, the industry standard steady-state one-dimensional model was used to check the hydraulic behaviour of major structures located along the river in the study area.

This section of the report describes the hydraulic modelling of the Brisbane River system with respect to the calibration and verification processes.

6.2 MIKE11 Model Description

The MIKE11 hydrodynamic model was developed by the Danish Hydraulic Institute and it is a one-dimensional dynamic model used to simulate flows in channels of various configurations.

The model is based on an implicit finite-difference approach and can be applied to looped networks and quasi two-dimensional flow simulations. The model is capable of simulating sub-critical as well as super-critical flow conditions through a numerical scheme which adapts according to local flow conditions.

Inputs to the model include discharge hydrographs at various inflow points, water level or discharge hydrographs at the downstream boundary of the model, cross-sectional data and channel roughness values.

6.3 HEC-RAS Model Description

HEC-RAS has been developed to predict water surface profiles for steady flow in natural or constructed channels. The computational procedure is based on the solution of the one dimensional energy equation with energy losses due to friction evaluated from Manning's equation. Effects of hydraulic structures such as bridges, culverts and weirs can be readily incorporated. For the purpose of this study, HEC-RAS has been used to check the performance of the MIKE11 model at bridge structures.

6.4 Model Establishment

6.4.1 Ipswich Rivers System Schematisation

The Brisbane River Flood Study hydraulic model (developed for the Brisbane River Flood Study) was extended to include the extent of works required by Phase 1 and Phase 2 of the Ipswich Rivers Flood Studies Brief.

The Brisbane River System refers to the hydraulic reaches of those rivers/creeks included in Phase 1 and Phase 2 of the Ipswich Rivers Flood Studies as well as the section of Brisbane River downstream of the Ipswich City Boundary (chainage BNE 1014.61 km). The extent of reach required by the brief only refers to the section of river/creek that has been input into the MIKE11 hydraulic model. These river/creek extents are discussed below:

- Brisbane River - was represented by one main branch in the MIKE11 model which extends from the Western Inner Bar to the Ipswich City Council and Esk Shire Council boundary which is located approximately 115 km upstream of Moreton Bay branches have been included in the model where large floodplain breakouts occur.
- Bremer River - was input as a single branch which connects to the Brisbane River at chainage BNE 1006.2 km and extends upstream approximately 28 km to where it connects with Warrill Creek. A number of floodplain breakout locations were identified on the Bremer River and these have been included in the hydraulic model.
- Warrill Creek - was represented by a single branch which connects to the Bremer River at chainage BREM 1000.0 km and extends approximately 8.1 km upstream to the Cunningham Highway. Warrill creek has a number of areas where floodplain flows occur and at these locations link branches have been included in the hydraulic model.
- Purga Creek - is a tributary of Warrill Creek and connects with Warrill Creek at chainage WAR 105.2 km and was represented in the MIKE11 model as a single branch. Purga Creek extends up to the Cunningham Highway which is approximately 2.5 km upstream of the confluence with Warrill Ck.

- Bundamba Creek - connects to the Bremer River at chainage BREM 1020.3 km and extends upstream approximately 31 km. Bundamba Creek has been modelled as a single branch however it has a number of tributaries named HWAY LEFT, LOW BRANCH1, LOW BRANCH2 and UP BRANCH1 which connect at chainages BUND 28.56 km, BUND 37.8 km, BUND 33.95 km and BUND 22.09 km respectively. Each of the creeks have been modelled as single branches.
- Deebing Creek - joins the Bremer River at chainage BREM 1004.65 km just downstream of the One Mile Bridge. Deebing Creek extends upstream approximately 10 km and has two main tributaries, Small Creek and Reedy Creek. These creeks join Deebing Creek at chainage DB 17.1 km and DB 16.2 km respectively. Each of the creeks have been modelled as single branches.
- Ironpot Creek - Is a tributary of the Bremer River and connects at chainage BREM1008 km. Ironpot Creek extends approximately 8.5 km upstream and has a tributary which has been named Ironpot_Banch1. Ironpot_Branch1 connects to Ironpot Creek at chainage IP 11.4 km. Each of the branches have been modelled as single branches.
- Mihi Creek - is a tributary of the Bremer River and extends upstream approximately 3 km. Its connection point to the Bremer River is located at chainage BREM 1009.82 km. Mihi Creek has a tributary which has been named Mihi_Branch1 which joins Mihi Creek at chainage MH 11.0 km. Each of the branches have been modelled as single branches.
- Sandy Creek (Chuwar) - connects to the Bremer River at chainage BREM 1020.5 km and extends upstream a distance of approximately 3.5 km. Sandy Creek (Chuwar) has been modelled as a single branch. No minor tributaries have been modelled.
- Six Mile Creek - is a tributary of the Brisbane River and connects at chainage BNE 1007.78 km. Six Mile Creek has been modelled as a single branch and extends upstream a distance of approximately 11 km. No tributaries of Six Mile Creek have been modelled.
- Goodna Creek - has been modelled as a single branch which extends upstream of its junction with the Brisbane River approximately 7 km. It connects with the Brisbane River at chainage BNE 1012.48 km . No tributaries of Goodna Creek have been modelled.
- Woogaroo Creek - is a tributary of the Brisbane River and connects at chainage BNE 1014.61 km. Woogaroo Creek has been modelled as a single branch and extends upstream a distance of approximately 9 km. No tributaries of Woogaroo Creek have been modelled.
- Sandy Creek (Camira) - is a tributary of the Brisbane River and connects at chainage BNE 1019.5 km. Sandy Creek (Camira) has been modelled as a single branch and extends upstream a distance of approximately 9 km. Note that only one cross section has been included in the hydraulic model within the Brisbane City Boundary and this has been included to enable Sandy Creek to be included in the Brisbane River System hydraulic model. No tributaries of Sandy Creek have been modelled.

- Additional branches located at the confluences of Oxley Creek, Enoggera Creek and Bulimba Creek were included in the model to allow major inflows and storages from these tributaries to be taken into account. Storages associated with other smaller tributaries were not considered to be significant and therefore were not included in the model. This was considered to be a reasonable representation as peak inflows from major tributaries within the hydraulic model reach occur well before peak inflows from the upper Brisbane River catchment (ie. upstream of the Brisbane City Boundary). This allowed floodwater to be backed up into each tributary and provided a simulated storage at each confluence. Model branches and major confluence locations are shown in **Ipswich Rivers Flood Study Atlas**.

Note that the reach of the Brisbane River between the Western Inner Bar (chainage BNE 1078.66 km) and the junction of the Brisbane River and Woogaroo Creek (chainage BNE 1014.61 km) has been included in the hydraulic model to enable analysis of varying tidal fluctuations. Results for this reach have not been included in this report.

6.4.2 Cross-Sectional Information

Brisbane River

Surveyed data provided by Brisbane City Council was used to describe the cross-sectional geometry of the Brisbane River system in the model between BNE 1000.00 km and BNE 1078.66 km. The remainder of the cross sectional information was obtained from the DNR (ie. BNE 964.17 km to BNE 1000.00 km), which was extracted from five metre contour plans (DNR). Several inconsistencies at a number of cross sections were uncovered in the DNR cross sectional information and a number of assumptions regarding bed levels had to be adopted. These assumptions were made based on surrounding level information at structures where possible.

Bremer River

Cross sectional information for the Bremer River was extracted from a combination of surveyed cross sections, 0.5 m contour plans (ICC), 5 m contours and bathometry information (DNR). A number of inconsistencies were found between the three sets of data, however from BREM 1015 km to BREM 1028 km, a combination of bathometry and 0.5 m contour plans were used to construct cross sections as this was the most recent data. The remainder of the river cross sections were developed using a combination of 0.5 m contour plans, 5 m contour plans and surveyed cross sections (Australian Survey Office 1975).

The DNR also provided cross sections however these were based on 5 m contours and it was considered that from the information above, a more accurate set of cross sectional information could be developed.

Bundamba Creek
Cross sections were taken directly from the Bundamba Creek Flood Study MIKE11 model (CMPS&F 1996) and input into the Ipswich Rivers Flood Studies hydraulic model. Several inconsistencies were found and these have been changed to reflect levels provided on the 0.5 m contour plans of the Ipswich Area.

Six Mile Creek, Sandy Creek (Camira), Woogaroo Creek, Goodna Creek, Deebing Creek, Mihi Creek and Ironpot Creek
Cross sections for each of these creeks were derived using 0.5 m contour plans where possible and 5 m contour plans in the remainder of the creeks. Some surveyed cross sections were taken around hydraulic structures and a comparison between the field survey and the contour plans was conducted. Where applicable, the cross sections developed from the contour plans were adjusted to match the surveyed sections.

Sandy Creek (Chuwar)
Surveyed cross sections were provided for Sandy Creek (Chuwar). Where additional cross sectional information was required 0.5 m and 5 m contour plans were used to extract the required information

Warrill and Purga Creek
Cross sectional information for these creeks was based on 5 m contour plans. The accuracy of these plans is considered to be ±2.5 m.

Oxley Creek, Breakfast Creek and Bulimba Creek
The geometry of the adjoining tributaries consisted of Brisbane River survey data (connection to Brisbane River) and derived levels from topographical information for the upstream cross sections.

Approximately 1010 cross-sections were used to represent the geometry of the Brisbane River and Bremer River Systems. The cross section locations are presented in **Ipswich Rivers Flood Study Atlas.**

6.4.3 Boundary Conditions
Discharge hydrographs simulated by the hydrologic model, RAFTS, for the various recorded events were used as boundary conditions at approximately 160 locations throughout the Ipswich River hydraulic model. These locations are presented in the **Ipswich Rivers Flood Study Atlas.** In addition to these locations, a base flow of 1 m^3/s was input at the top of each river and 0.1 m^3/s in the creeks to keep the model from drying out which helps with the model stability.

Recorded water levels in the Brisbane River at the Western Inner Bar were used as the downstream boundary conditions for the events being modelled.

6.4.4 Hydraulic Structures

A total of 54 waterway crossings are located within the Ipswich Rivers Flood Studies area and a further 8 waterway crossings are located on the Brisbane River, downstream of the Ipswich City Boundary. These structures have been included in the hydraulic model as the affluxes caused by these structures may increase flood levels in the Ipswich area. The location of each of these structures are shown in the **Ipswich Rivers Flood Study Atlas**. Geometry and hydraulic capacity vary considerably between crossings, but they can all be grouped into bridge or culvert structure types.

Bridge Structures consist of a road decking supported by piers. This type of structure has the highest capacity to accommodate flood discharges without overtopping. Changes to waterway geometry are usually minor compared to other structures such as culverts, except for the piers and encroachment of the creek by the bridge abutments.

Two types of flow regimes were allowed for in the hydraulic modelling of waterway structures:

Weir Type Flow is the flow over a crest such as a road or top of a pipeline. This occurs when the roadway is overtopped and may be either free flow (low downstream water levels causing critical flow conditions at the structure) or submerged flow (high downstream water levels 'drowning' out the weir flow).

Culvert Type Flow is the flow through a culvert opening. The hydraulics of culvert flow are dependent on factors such as downstream submergence, culvert dimensions and geometry, friction effects and whether the culvert is flowing partially full or is pressurised.

The modelling approach for each bridge structure was a combination of culvert and weir flow. Flows below the bridge deck were assumed to approximate a culvert type regime.

A relationship between water level and available waterway width was developed from cross sectional information. Reductions in waterway area due to piers and bridge skewness were taken into account. The level-width curve was then input into MIKE11.

This approach was applied to flows below the bridge deck. For overtopping conditions, the road crest geometry was specified directly into MIKE11 and modelled as a broad crested weir. Where handrails or guardrails were located these were assumed to be fully blocked by debris.

A brief description of each structure is provided below on a river by river basis.

Bremer River

1. One Mile Bridge - is a multi span structure consisting of a constant deck depth with 8 piers and abutments encroaching onto the waterway area. This structure spans both the Bremer River and Deebing Creek and has been split into two separate structures with the appropriate structure being applied to the relevant river/creek. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions. No datum was given on the design plans and therefore a deck level was provided in Australian Height Datum (AHD) by Ipswich City Council. This allowed levels on the design plan to be adjusted to AHD.

2. Wulkaraka Rail Bridge - is a multi span structure consisting of a constant deck depth with 14 piers and abutments encroaching into the waterway area. This bridge spans the Bremer River and is a steel truss type structure. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions.

3. Hancock Bridge - is a multi span structure consisting of a constant deck depth with 4 piers and abutments encroaching onto the waterway area. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions.

4. Railway Workshops Bridge - is a multi span structure consisting of a constant deck depth with 2 piers and abutments encroaching onto the waterway area. This bridge spans the Bremer River and is a steel truss type structure. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions.

5. David Trumpy Bridge - is a multi span structure consisting of a constant deck width with 6 piers and abutments encroaching onto the waterway area. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions. Ipswich City Council provided a deck level and design plan levels were adjusted to account for variations in levels during construction.

6. Warrego Highway Bridges - are 2 parallel bridges located at a distance of 10 m apart. Both are multi span structures consisting of a constant deck depth with 13 piers and abutments encroaching onto the waterway area. "As constructed" plans of this structure were unavailable and hence design plans were used for structure dimensions. Ipswich City Council provided a deck level and design plan levels were adjusted to account for variations in levels during construction. These bridges were modelled as a single structure, however to account for the additional afflux caused by the second bridge, the Dual Bridges Method set down in Waterway Design (Austroads 1994) was used.

Brisbane River

7. Kholo Bridge - is a multi span structure consisting of 8 piers. The bridge has a constant depth of deck and is of timber construction. Survey of this bridge has been conducted and this information was used in the hydraulic model.

8. Mt Crosby Weir - is an ogee type weir which underlies a road. The road is supported by 17 piers. Design plans were used to determine weir and bridge deck levels and hence the reliability of the levels are questionable. This was a complex structure to model as the roadway located above the ogee weir acted as a broad crested weir. As MIKE11 was unable to model this structure, the weir was set up in HEC-RAS and its hydraulic characteristics assessed. Based on this assessment a modified broad crested weir was input into the MIKE11 model.

9. Colleges Crossing Bridge - is a multi opening structure which consists of a multi span bridge with 2 piers and a set 8-2700x900 RCBC culverts. Design plans for this structure were provided and hence the reliability of the bridge details is questionable.

10. Centenary Bridge - A multi span structure consisting of a constant deck depth with 6 piers and abutments encroaching within the waterway area. During the 1974 flood event a barge was sunk immediately upstream of the bridge to avoid bridge damage occurring. This may have caused a reduction of the conveyance through the waterway.

11. Indooroopilly Bridge - There are two bridges in this location these being the Walter Taylor Bridge and the Indooroopilly Rail Bridge. For modelling purposes the two bridges were combined and assumed to be a composite structure. Anecdotal evidence suggests that the combination of these two structures reduce the waterway area and cause a choking effect.

12. The Merivale Bridge - This rail bridge was constructed after the 1974 flood event. It has been included for all events occurring after 1974. It is a multi span structure with 2 piers.

13. William Jolly Bridge - This bridge is situated approximately 250 m downstream of the Merivale bridge. The bridge is a multi span bridge with arched chords joining the piers at low levels. It is considered that these arched chords may cause some minor afflux to occur due to the reduction in waterway area.

14. Victoria Bridge - The Victoria Bridge is located approximately 700 m downstream of the William Jolly Bridge. The bridge is a solid arch bridge which reduces the waterway area considerably at higher flood levels.

15. Captain Cook Bridge - This bridge is similar to the Victoria Bridge however the reduction in waterway area is less due to the flat arch shape of the deck.

16. Story Bridge - The deck level of the Storey Bridge is such that weir flow is unlikely for most floods. Any restriction of flow is due to the piers and abutments only, hence major affluxes at this location are not expected.

17. Gateway Bridge - This bridge was not included in the model as the deck is suspended at a very high level. The effect of the piers on afflux was considered to be negligible due to the extent of waterway area at this location.

Bundamba Creek

18. Ripley Road Bridge - is of timber construction with a deck of constant depth. The bridge is a multi span structure which has one pier and the bridge abutments encroach into the waterway area. Levels for this structure were provided by the Queensland University of Technology (QUT). The survey was conducted by students and there seems to be a number of anomalies between contour information and survey information at this location. The QUT survey levels were used as these levels were considered to be the best available information however there is some concern about the quality of the data at this location.

19. Swanbank Road Bridge - is a multi span concrete bridge with 2 piers with constant deck depth and abutments which encroach into the waterway area. Levels for this structure were provided by the Queensland University of Technology (QUT). The survey was conducted by students and there seems to be a number of anomalies between contour information and survey information at this location. The QUT survey levels were used as these levels were considered to be the best available information however there is some concern regarding the quality of the data at this location.

20. Patrick St Bridge - is a timber bridge which has 2 piers and abutments which encroach into the waterway area. Information used for the Bundamba Creek Flood Study (CMPS&F 1996) was used as MIKE11 input.

21. Cunningham Highway Bridge & Culverts - this road crossing consists of a multi span bridge structure with 1 pier, 5-2700x1800 RCBC's, 12-2400x1200 RCBC's and 5-2700x1800 RCBC's. The bridge structure, 5-2700x1200 RCBC's and 12-2400x1200 RCBC's have been modelled in the Bundamba Creek branch of the MIKE11 model and the other set of 5-2700x1800 RCBC's have been modelled in the Highway Left branch of the model. This section of the Cunningham Highway is a dual carriage way and hence the dual bridges method has been utilised. Levels for this structure were provided by the Queensland University of Technology (QUT). The survey was conducted by students and there seems to be a number of anomalies between contour information and survey information at this location. The QUT survey levels were used as these levels were considered to be the best available information however there is some concern regarding the quality of the data at this location. Note that these structures were not present in 1974 as the Cunningham Highway had not been constructed and were therefore omitted from the 1974 calibration event.

22. Blackstone Rail Bridge - is a multi span timber bridge with 7 piers which has abutments which encroach into the waterway area. Levels for this structure were obtained directly from the Bundamba Creek Flood Study (CMPS&F 1996) however these levels did not agree with contour information in the area and several changes had to be made to these levels due to inconsistencies between cross sectional information and bridge levels.

23. Brisbane Road Bridge - is a multi span bridge with 3 piers with abutments which encroach into the waterway area. Brisbane Road is a dual carriage way and the dual bridges method was utilised in the analysis. Level information was obtained from both the Bundamba Creek Flood Study (CMPS&F 1996) and design plans. This information was reviewed and the most appropriate deck levels etc. were selected.

24. Blackstone Road Bridge - is a multi span bridge with 1 pier which has abutments which encroach into the waterway area. Levels for this structure were obtained directly from the Bundamba Creek Flood Study (CMPS&F 1996) however these levels did not agree with contour information in the area and additional survey was conducted by Ipswich City Council. Levels from the CMPS&F study were then adjusted using the available survey information.

25.Basketball Rail Bridge - is a multi span timber bridge with 9 piers which has abutments which encroach into the waterway area. Levels for this structure were obtained directly from the Bundamba Creek Flood Study (CMPS&F 1996) however these levels did not agree with contour information in the area and several changes had to be made to these levels due to inconsistencies between cross sectional information and bridge levels.

26.Ipswich-Brisbane Rail Bridge - is a multi span bridge with 4 piers which has abutments which encroach into the waterway area. Level information was obtained from both the Bundamba Creek Flood Study (CMPS&F 1996) and design plans. This information was reviewed and the most appropriate deck levels etc. were selected.

27.Gledson Street Bridge - is a multi span bridge with 1 piers which has abutments which encroach into the waterway area. Level information was obtained from both the Bundamba Creek Flood Study (CMPS&F 1996) and design plans. This information was reviewed and the most appropriate deck levels etc. were selected.

Six Mile Creek

28.Hallets Road Bridge - is a multi span timber bridge with 1 pier which has abutments which encroach into the waterway area.

29.Redbank Plains Road Crossing - is a culvert structure which is controlled by 2-3000x2100 arched culverts. Survey information for these culverts was provided.

30.Ipswich Road Bridge - is a multi span bridge with 4 piers and abutments which encroach into the waterway area. The structure is located on a dual carriage way however the two structures are situated less than one metre apart and have hence been modelled as a single structure. Design plans were used for level information.

31.Six Mile Creek Rail Bridge - is a multi span bridge with 5 piers and abutments that encroach into the waterway area. Level information was provided via design plans.

Goodna Creek

32.Kruger Parade Road Crossing - is a culvert structure which is controlled by 1-5500x2000 arched culvert. Survey information for this culvert was provided.

33.Ipswich Road Crossing - is a complex set of structures which consist of 3 parallel structures. The first structure is a set of 3-6500x3500 arched culverts which are located on the off ramp adjacent to Ipswich Road. Ipswich Road is a dual carriage way and has two identical bridges parallel to each other. These bridges are multi span structures with 1 pier and abutments that encroach into the waterway area. The off ramp structure is the hydraulic control as it has the smallest waterway area however additional afflux will be caused by the two Ipswich Road bridges.

Although use of the dual bridges method is not strictly correct for this application (as all of the structures in parallel are not identical), it was considered to be the best available methodology and hence this method was applied. As such, the arch culverts were used in the model and a factor was applied to account for the additional afflux caused by the two Ipswich Road bridge structures. Level information was obtained from design plans and contour information.

34.Goodna Creek Rail Bridge - consists of a set of 3-3000x3000 RCBC's and a single span bridge. Levels for these structure were provided via design plans and contour plans.

35.Brisbane Terrace Road Crossing - consists of 1-3800x3800 RCBC. Level information was provided via survey.

Sandy Creek (Camira)

36.Addison Road Crossing - consists of 4-1800x1200 RCBC's. Level and culvert information was provided via survey.

37.Cockrane Street Crossing - consists of 8-1200x1200 RCBC's and 6-1200x1300 RCBC's. Level and culvert information was provided via survey.

38.Ishmael Street Crossing - consists of 5_2100x900 RCBC's. Level and culvert information was provided via survey.

39.Logan Motorway Crossing - consists of 7-3000x3000 RCBC's and 3-3000x1200 RCBC's. Level and culvert information was provided via survey.

Woogaroo Creek

40. Edna Street Crossing - is a single span timber bridge with abutments which encroach into the waterway area. Level information was provided via survey.

41. Ipswich Road Bridge - is a multi span bridge consisting of 3 piers and abutments which encroach into the waterway area. Level information was provided via design plans. This structure is a dual bridge however it has been modelled as a single bridge as the two bridges are situated less than two metres apart.

42. Ipswich-Brisbane Rail Bridge - is a multi span bridge consisting of 4 piers and abutments which encroach into the waterway area. Level information was provided via design plans.

43. Brisbane Terrace Bridge - is a multi span bridge consisting of 2 piers and abutments which encroach into the waterway area. Level information was provided via design plans.

Deebing Creek

44. Brisbane Street Bridge - is a multi span bridge with 1 pier and abutments which encroach into the waterway area. Level information was provided via survey.
45. Sandy Gallop #5-6 - is a single span bridge with abutments which encroach into the waterway area. At the base of the waterway area are 2, 750 RCP's. Level information was provided via survey.

46. Sandy Gallop #4 - is a small weir.

47. Sandy Gallop #3 - is a single span bridge with abutments which encroach into the waterway area. Level information was provided via survey.

48. Sandy Gallop #2 - is a multi span bridge with two 1725 RCP's either side of a central pier. Level information was provide by survey.

49. Sandy Gallop # 1 - consists of one 1550 RCP. Level and culvert information was provided via survey.

50. Warwick Road Bridge - is a multi span bridge consisting of 3 piers and abutments which encroach into the waterway area. Level information was provided via design plans.

51. Ash Street Bridge - consists of three 3600 x 3600 RCBC's and one 3600 x 3820 RCBC. Level and culvert information was provided via survey.

52.Cunningham Highway Crossing - Is a multi span bridge consisting of 2 piers and abutments which encroach into the waterway area. Level information was provided via design plans.

Ironpot Creek

53.Sydney Street Bridge - consists of one 2920 steel Armco pipe. Level and culvert information was provided via survey.

54.Warrego Highway Bridge - is a multi span bridge consisting of 1 pier and abutments which encroach into the waterway area. Level information was provided via design plans.

55.Wairuna Court Crossing - consists of three 910 RCP's. Level and culvert information was provided via survey.

Mihi Creek

56.Hunter Street Bridge - consists of five 1820 RCP's. Level and culvert information was provided via survey.

57.Fernvale Road Bridge - consists of five 1835 square RCBC's. Level and culvert information was provided via survey.

58.Pine Mountain Road Bridge - consists of four 1830 square RCBC's. Level and culvert information was provided via survey.

59.Warrego Highway Bridge - consists of one 1500 RCP. Level and culvert information was provided via survey.

Sandy Creek (Chuwar)

60.Mount Crosby Road Bridge - is a multi span bridge consisting of 1 pier and abutments which encroach into the waterway area. Level information was provided via survey.

61.Warrego Highway Bridge - consists of three box culverts. Upstream and downstream measurements of the culvert diameters differed. Two of the culverts are 3700 x 3660 while the central culvert is approximately 3850 x 3900. Level and culvert information was provided via survey.

62.Robin Street Crossing - consists of one 300 RCP. Level and culvert information was provided via survey.

A list of the modelled structures and how they were represented in MIKE11 are presented in **Table 6.1: List of Hydraulic Structures.**

Table 6.1: List of Hydraulic Structures

No	Structure Location	Chainage (km)	Structure Description	Modelled in MIKE11 as:
Bremer River				
1	One Mile Bridge	1004.600	Major Public Bridge	Irregular culvert + weir
2	Wulkaraka Rail Bridge	1006.500	Major Public Bridge	Irregular culvert + weir
3	Hancock Bridge	1008.400	Major Public Bridge	Irregular culvert + weir
4	Railway Workshops Bridge	1011.800	Minor Public Bridge	Irregular culvert + weir
5	David Trumpy Bridge	1012.06	Major Public Bridge	Irregular culvert + weir
6	Warrego Highway Bridge	1023.500	Major Public Bridge	Irregular culvert + weir
Brisbane River				
7	Kholo Bridge	979.510	Minor Public Bridge	Irregular culvert + weir
8	Mt Crosby Weir	988.165	Water Supply Weir	weir
9	Colleges Crossing	992.46	Minor Public Bridge	Culvert, irregular culvert + weir
10	Centenary Highway	1028.720	Major Public Bridge	Irregular culvert + weir
11	Indooroopilly Bridges	1037.110	Major Public Bridge	Irregular culvert + weir
12	Merivale Bridge	1052.37	Major Public Bridge	Irregular culvert + weir
13	William Jolly Bridge	1052.625	Major Public Bridge	Irregular culvert + weir
14	Victoria Bridge	1053.356	Major Public Bridge	Irregular culvert + weir
15	Captain Cook Bridge	1054.660	Major Public Bridge	Irregular culvert + weir
16	Story Bridge	1056.020	Major Public Bridge	Irregular culvert + weir
17	Gateway Bridge	1068.660	Major Public Bridge	Not Modelled
Bundamba Creek				
18	Ripley Road Bridge	18.740	Minor Public Bridge	Irregular culvert + weir
19	Swanbank Road Bridge	25.590	Minor Public Bridge	Irregular culvert + weir
20	Patrick St Bridge	27.390	Minor Public Bridge	Irregular culvert + weir
21	Cunningham Highway Bridge & Culverts	28.510	Major Public Bridge	Culvert, irregular culvert + weir
22	Blackstone Road Bridge	31.990	Major Public Bridge	Irregular culvert + weir
23	Blackstone Rail Bridge	32..360	Minor Public Bridge	Irregular culvert + weir
24	Brisbane Road Bridge	34.325	Major Public Bridge	Irregular culvert + weir
25	Basketball Rail Bridge	35.110	Minor Public Bridge	Irregular culvert + weir
26	Ipswich-Brisbane Rail Bridge	35.530	Major Public Bridge	Irregular culvert + weir
27	Gledson St Bridge	36.015	Minor Public Bridge	Irregular culvert + weir
Six Mile Creek				
28	Hallets Road Bridge	10.377	Minor Public Bridge	Irregular culvert + weir
29	Redbank Plains Rd Crossing	11.785	Minor Public Bridge	Regular culvert + weir
30	Ipswich Rd Bridge	19.850	Major Public Bridge	Irregular culvert + weir
31	Six Mile Ck Rail Bridge	20.150	Major Public Bridge	Irregular culvert + weir

Table 6.1: List of Hydraulic Structures (Cont)

No	Structure Location	Chainage (km)	Structure Description	Modelled in MIKE11 as:
Goodna Creek				
32	Kruger Pde Road Crossing	12.032	Minor Public Xing	Irregular culvert + weir
33	Ipswich Road Crossing	14.235	Major Public Bridge	Irregular culvert + weir
34	Goodna Creek Rail Bridge	14.505	Major Public Bridge	Irregular culvert + weir
35	Brisbane Tce Road Crossing	14.913	Minor Public Xing	Regular culvert + weir
Sandy Creek (Camira)				
36	Addison Rd Crossing	11.051	Minor Public Xing	Regular culvert + weir
37	Cochrane St Crossing	11.529	Minor Public Xing	Regular culvert + weir
38	Ishmael St Crossing	12.009	Minor Public Xing	Regular culvert + weir
39	Logan Motorway Crossing	14.720	Major Public Bridge	Irregular culvert + weir
Woogaroo Creek				
40	Edna Street Crossing	15.850	Minor Public Xing	Regular culvert + weir
41	Ipswich Road Bridge	17.340	Major Public Bridge	Irregular culvert + weir
42	Woogaroo Ck Rail Bridge	17.450	Major Public Bridge	Irregular culvert + weir
43	Brisbane Tce Bridge	17.770	Minor Public Bridge	Irregular culvert + weir
Deebing Creek				
44	Brisbane Street Bridge	19.837	Major Public Bridge	Irregular culvert + weir
45	Sandy Gallop #5-6	19.122	Golf Cse crossing	Irregular culvert + weir
46	Sandy Gallop #4	18.491	Golf Cse crossing	weir
47	Sandy Gallop #3	18.347	Golf Cse crossing	Irregular culvert + weir
48	Sandy Gallop #2	17.923	Golf Cse crossing	regular culvert + weir
49	Sandy Gallop #1	17.709	Golf Cse crossing	regular culvert + weir
50	Warwick Road Bridge	17.072	Major Public Bridge	Irregular culvert + weir
51	Ash Street	13.905	Major Public Bridge	regular culvert + weir
52	Cunningham Highway	12.937	Major Public Bridge	Irregular culvert + weir
Ironpot Creek				
53	Sydney St Bridge	18.375	Minor Public Bridge	regular culvert + weir
54	Warrego Highway Bridge	12.641	Major Public Bridge	Irregular culvert + weir
55	Wairuna Crt Crossing	1.868	Minor Public Xing	regular culvert + weir
Mihi Creek				
56	Hunter St Bridge	11.206	Major Public Bridge	regular culvert + weir
57	Fernvale Rd Bridge	10.728	Major Public Bridge	regular culvert + weir
58	Pine Mountain Rd Bridge	2.580	Major Public Bridge	regular culvert + weir
59	Warrego Highway Bridge	1.352	Major Public Bridge	regular culvert + weir

Table 6.1: List of Hydraulic Structures (Cont)

No	Structure Location	Chainage (km)	Structure Description	Modelled in MIKE11 as:
Sandy Creek (Chuwar)				
60	Mt Crosby Road Bridge	12.449	Major Public Bridge	irregular culvert + weir
61	Warrego Highway Bridge	11.907	Major Public Bridge	regular culvert + weir
62	Robin Street Crossing	10.805	Minor Public Bridge	regular culvert + weir

6.5 MIKE11 Model Calibration

6.5.1 General

Model calibration involves the selection of appropriate model schematisation and model parameters in order to match simulated and recorded water levels and discharges. This involves an iterative process and the careful selection of roughness parameters which reflect channel and floodplain conditions and an accurate description of flow movement.

Channel roughness values (Manning's `n') selected were primarily based on site visits, examination of aerial photographs and past experience from other flood studies. These were modified in some cases to reflect the hydraulic behaviour of the flood, (such as a change in vegetation or the presence of a sharp bend), as it moved downstream in order to achieve a reasonable match between recorded and predicted flood levels.

Four recorded events covering a variable range of floods, with rainfall and water level data were used to calibrate the hydraulic model. These flood events were:

- 11 December 1991 (Bundamba Creek only)
- 24 January 1974
- 01 May 1996
- 23 April 1989
- 20 June 1983

The calibration events can be classified into a large flood event (1974) and small flood events (1983, 1989, and 1996). The peak discharge of the 1974 flood event in the Brisbane River was approximately 10 000 m^3/s, while the other events discharges range from 1 500 m^3/s to 3 000 m^3/s. Unfortunately no historical records for mid range flood events were available at the time of calibration. The 1991 flood event was assessed on Bundamba Creek only as this was the largest recorded local catchment event in recent history.

Adopted Manning's 'n' values used in the hydraulic model are shown in the following Figures:

- Figure 6.1: Brisbane River - Hydraulic Model Roughness
- Figure 6.2: Bremer River - Hydraulic Model Roughness
- Figure 6.3: Bundamba Creek River - Hydraulic Model Roughness
- Figure 6.4: Warrill Creek - Hydraulic Model Roughness
- Figure 6.5: Purga Creek - Hydraulic Model Roughness
- Figure 6.6: Woogaroo Creek- Hydraulic Model Roughness
- Figure 6.7: Sandy Creek (Camira) - Hydraulic Model Roughness
- Figure 6.8: Six Mile Creek - Hydraulic Model Roughness
- Figure 6.9: Goodna Creek - Hydraulic Model Roughness
- Figure 6.10: Deebing Creek - Hydraulic Model Roughness
- Figure 6.11: Sandy Creek (Chuwar) - Hydraulic Model Roughness
- Figure 6.12: Mihi Creek - Hydraulic Model Roughness
- Figure 6.13: Ironpot Creek - Hydraulic Model Roughness.

The calibration process resulted in two sets of Manning's 'n' data in order to achieve a good calibration. The higher set of Manning's 'n' values (illustrated in **Figures 6.1** to **6.13** were required to match the predicted water levels to the recorded water levels for the 1974 flood. Since MIKE11 does not directly allow for bend losses, Manning's 'n' values had to be increased at bends to account for these losses. Furthermore, the predicted velocities in the 1974 flood were double that of the smaller events, hence increasing bend losses further. To account for the greater bend losses, the Manning's 'n' values had to be increased for the calibration of the 1974 flood event. Further discussion of the adopted Manning's 'n' values is provided later in this report.

Initial roughness estimates were based on site inspection and refined during the calibration process to achieve a best fit across the range of the four calibration events analysed.

A brief description of each of the rivers/creeks is given below on a reach by reach basis.

Bremer River, Warrill Creek and Purga Creek

Generally the upper reaches of the Bremer River (BREM 1000 km to BREM 1003 km), Warrill Creek and Purga Creek could be described as mainly open grassed floodplains with reasonably heavily treed channels with severe meanders at various locations. Rural properties are located at various intervals and levels along this reach.

From chainages BREM 1003 km to BREM 1019 km the Bremer River consists of mainly open grassed and treed floodplains with severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

The lower reach of the Bremer River from BREM 19 km to BREM 28 km is relatively uniform with no major bends. Rural Residential properties line the banks.

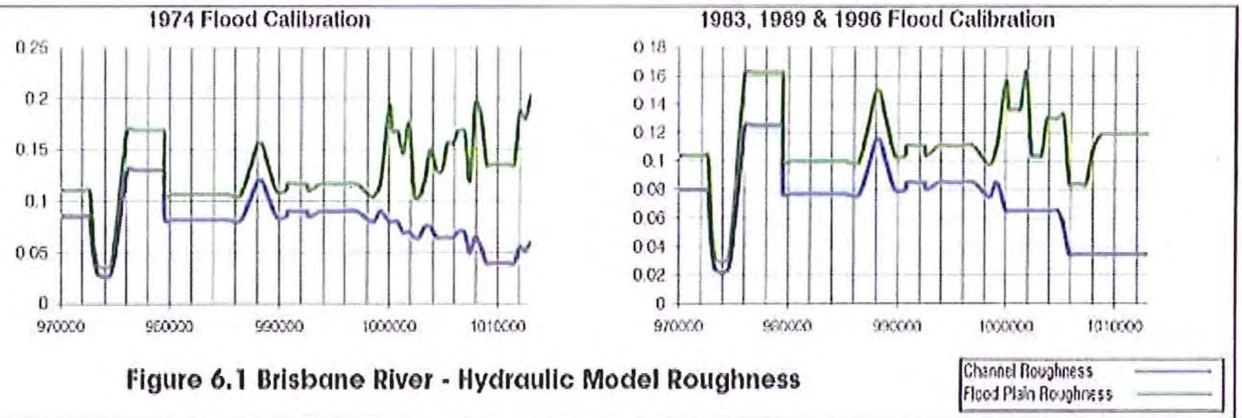


Figure 6.1 Brisbane River - Hydraulic Model Roughness

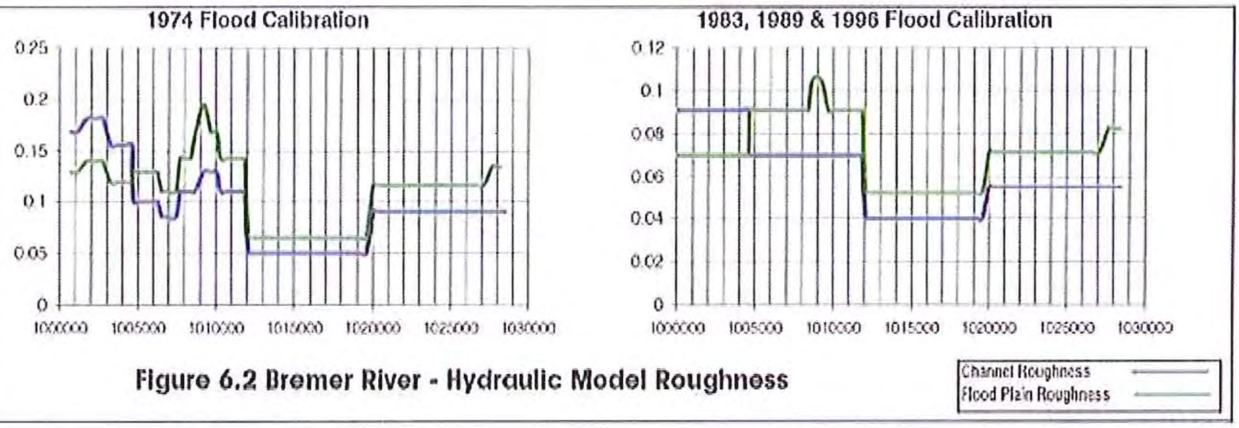


Figure 6.2 Bremer River - Hydraulic Model Roughness

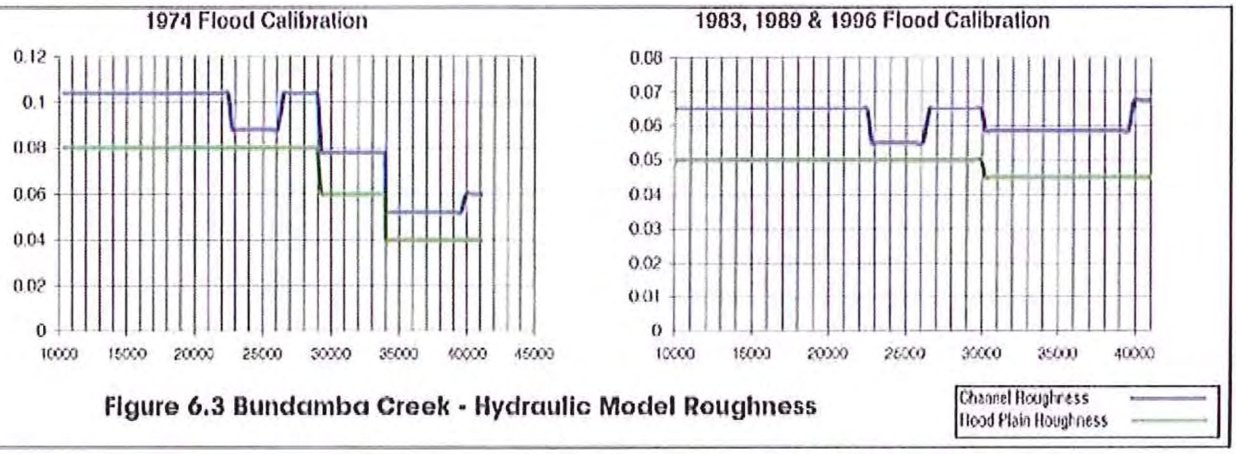


Figure 6.3 Bundamba Creek - Hydraulic Model Roughness

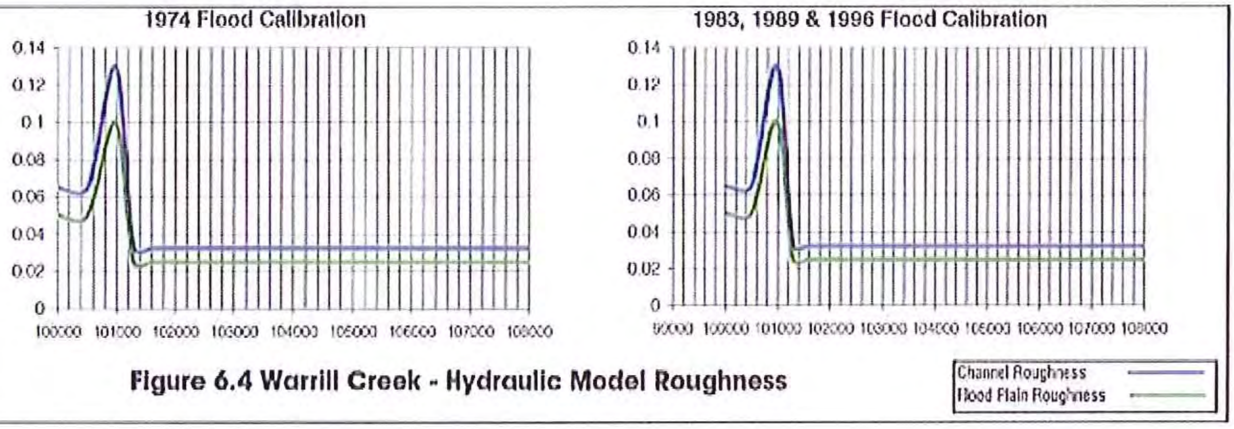


Figure 6.4 Warrill Creek - Hydraulic Model Roughness

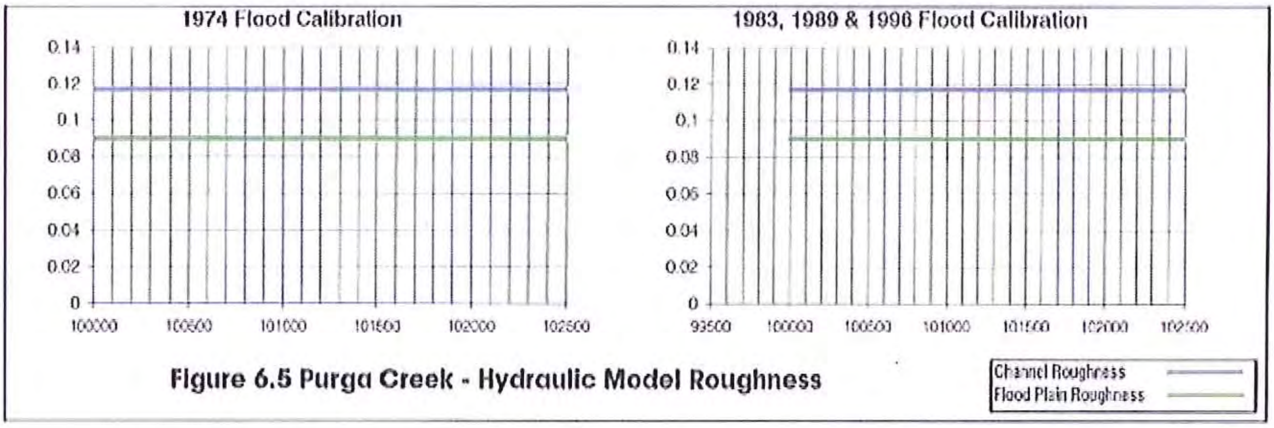


Figure 6.5 Purga Creek - Hydraulic Model Roughness

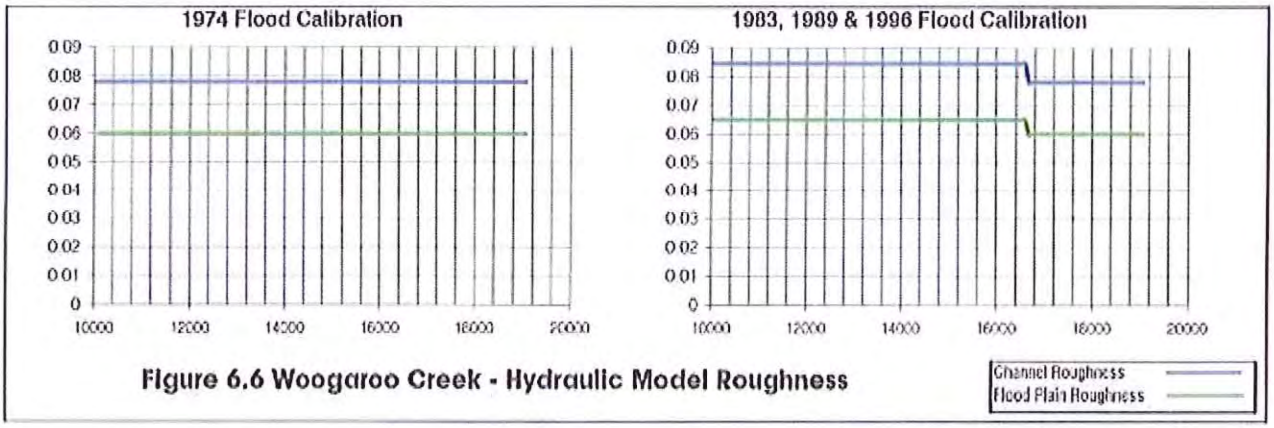


Figure 6.6 Woogaroo Creek - Hydraulic Model Roughness

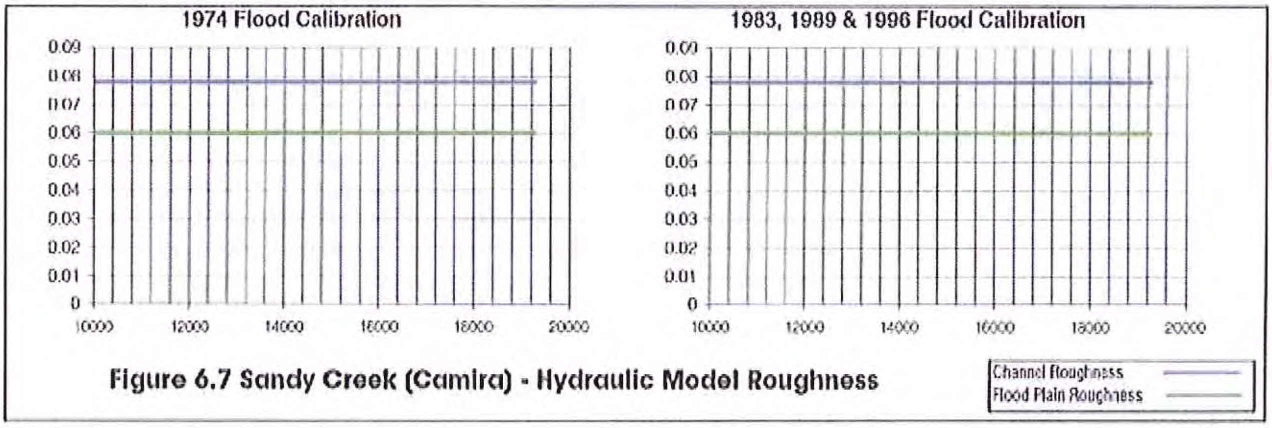


Figure 6.7 Sandy Creek (Camira) - Hydraulic Model Roughness

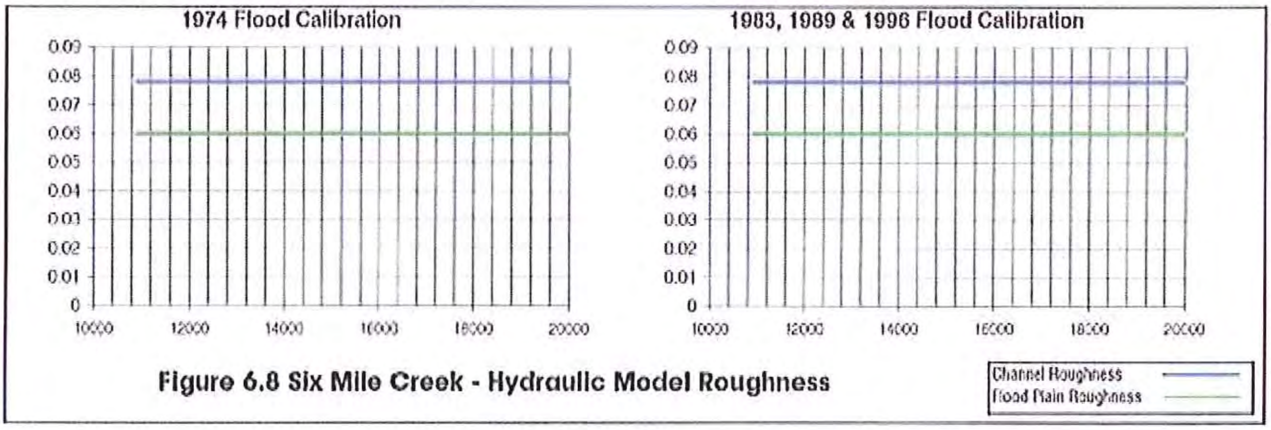


Figure 6.8 Six Mile Creek - Hydraulic Model Roughness

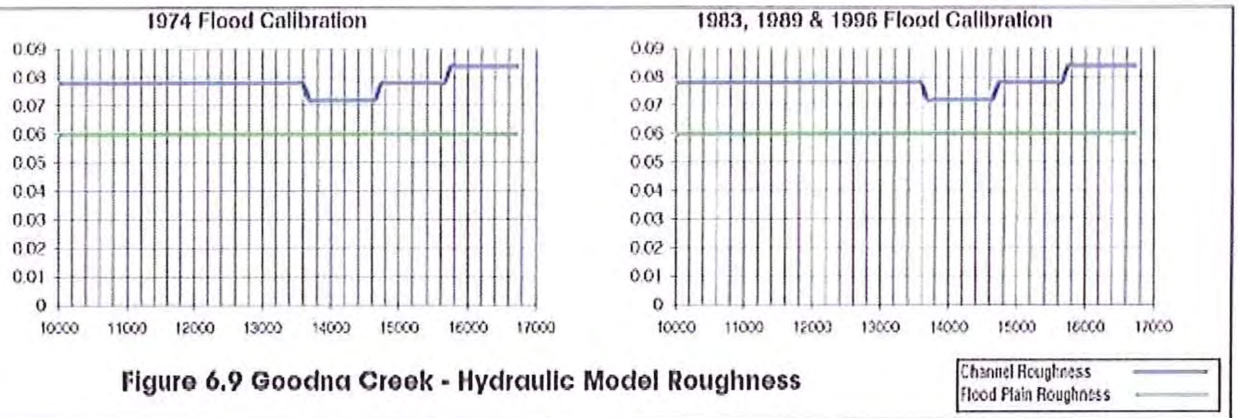


Figure 6.9 Goodna Creek - Hydraulic Model Roughness

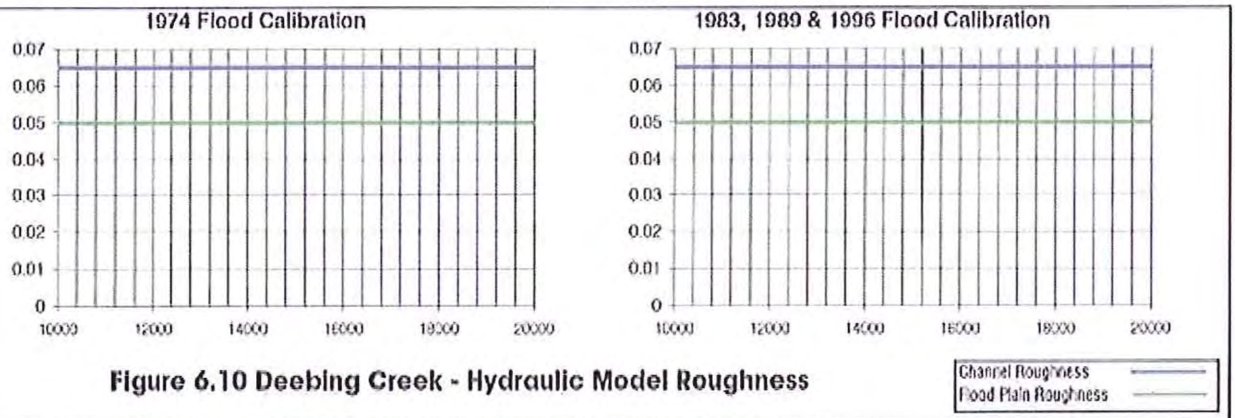


Figure 6.10 Deebing Creek - Hydraulic Model Roughness

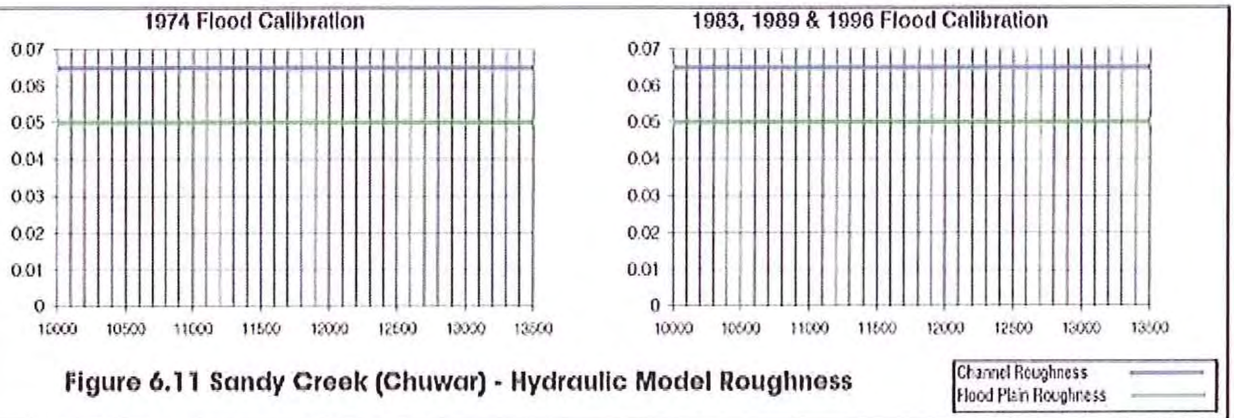


Figure 6.11 Sandy Creek (Chuwar) - Hydraulic Model Roughness

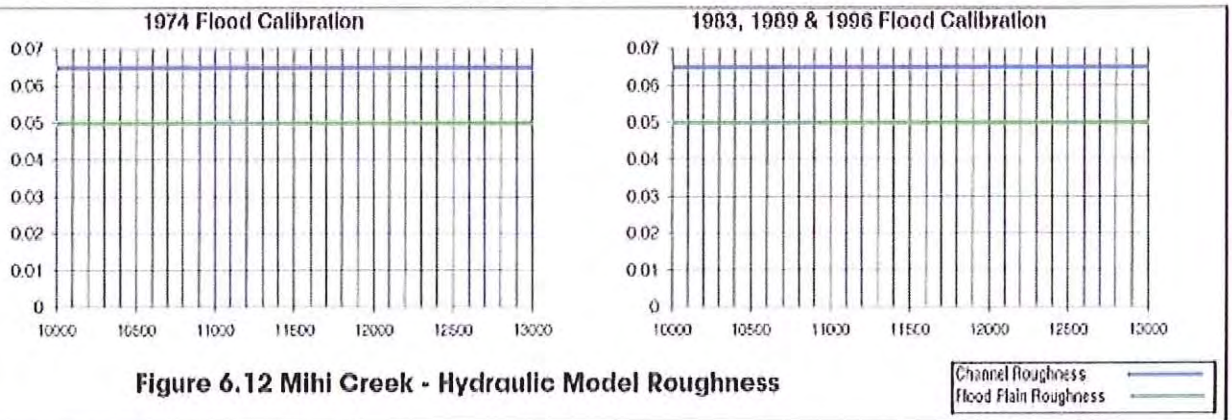


Figure 6.12 Mihi Creek - Hydraulic Model Roughness

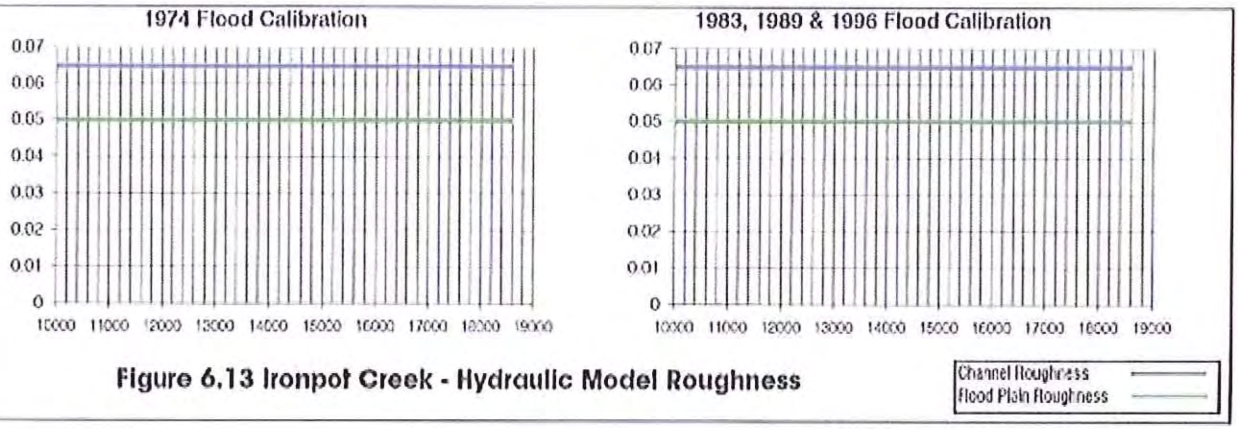


Figure 6.13 Ironpot Creek - Hydraulic Model Roughness

Brisbane River
Generally, the upper reach of the Brisbane River from MIKE11 model chainage BNE 964 km to BNE 990 km consists of mainly open grassed and treed floodplains with severe meanders at various locations. Rural properties are located at various intervals and levels along this reach.

The reach of the Brisbane River from MIKE11 model chainage BNE 990 km to BNE 1 040 km consists of mainly open grassed and treed floodplains with severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low density areas.

From chainage BNE 1 040 km to BNE 1 070 km the reach could be described as medium to high density residential areas which include the inner city area. The general shape of the river could be described as severely meandering.

The lower reach of the Brisbane River from BNE 1 070 km to BNE 1 078.66 km is relatively uniform with no major bends. Industry and residential properties line the banks along with mangrove swamps close to the river outlet.

Deebing Creek
Generally the upper reaches of Deebing Creek (DEEB 10 km to DEEB 13 km) could be described as mainly open grassed floodplains with lightly treed channels with moderate meanders at various locations. Rural properties are located at various intervals and levels along this reach.

From chainages DEEB 13 km to DEEB 20 km, Deebing Creek consists of mainly open grassed and treed floodplains with moderate meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

Ironpot Creek
The upper reaches of Ironpot Creek (IP 10 km to IP 13 km) consist of mainly open grassed and treed floodplains with slight meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low density areas.

From chainages IP 13 km to IP 19 km Ironpot Creek consists of mainly open grassed and treed floodplains with slight meanders at various locations. Rural properties are located at various intervals and levels along this reach.

Mihi Creek
Generally the upper reaches of Mihi Creek (MIHI 10 km to MIHI 13 km) could be described as mainly open grassed floodplains with lightly treed channels and meanders at various locations. Residential properties are located at various intervals and levels along this reach.

Bundamba Creek
Generally the upper reaches of the Bundamba Creek (BUND 10 km to BUND 29 km) could be described as mainly open, grassed floodplains with reasonably heavily treed channels and severe meanders at various locations. Rural properties are located at various intervals and levels along this reach.

From chainages BUND 29 km to BUND 38 km, Bundamba Creek consists of a mix of open grassed and treed floodplains with severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

The lower reach of Bundamba Creek from BUND 38 km to BUND 41 km is open grassed floodplains with a severely meandering channel. Rural Residential properties line the banks.

Sandy Creek (Chuwar)
The entire reach of Sandy Creek is predominantly open grassland and treed floodplains with slight meanders at various locations. Rural residential properties line the banks.

Six Mile Creek
From chainage SIX 9 km to SIX 11 km and SIX 16 to SIX 20 km Six Mile creek could be described as mainly open grassed floodplains with reasonably heavily treed channels containing severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

From chainages SIX 11 km to SIX 16 km Six Mile Creek consists of mainly open grassed and treed floodplains with severe meanders at various locations. Rural properties are located at various intervals and levels along this reach.

Goodna Creek

Generally the upper reaches of Goodna Creek (GOOD 10 km to GOOD 11 km) could be described as mainly open, grassed floodplains with reasonably heavily treed channels and slight meanders at various locations. Rural properties are located at various intervals and levels along this reach.

From chainages GOOD 11 km to GOOD 17 km Goodna Creek consists of mainly open grassed and treed floodplains with severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

Woogaroo Creek

Generally the upper reaches of Woogaroo Creek (WOOG 10 km to WOOG 11 km) could be described as mainly open grassed floodplains with reasonably heavily treed channels with severe meanders at various locations. Rural properties are located at various intervals and levels along this reach.

From chainages WOOG 11 km to WOOG 19 km Woogaroo Creek consists of mainly open grassed and treed floodplains with severe meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

Sandy Creek (Camira)

Generally the upper reaches of the Sandy Creek (SAND 10 km to SAND 13 km) could be described as mainly open grassed floodplains with reasonably heavily treed channels with moderate meanders at various locations. Residential properties are located at various intervals and levels along this reach. These residential properties could be described as being in low to medium density areas.

From chainages SAND 13 km to SAND 15 km Sandy Creek consists of mainly open grassed and treed floodplains with moderate meanders at various locations. Rural properties are located at various intervals and levels along this reach.

Generally the overall river and creek bed profiles could be described as irregular which is probably due to dredging, scouring or shifting of the bed during significant flood events. This form of roughness may cause a slight increase to the expected Manning's 'n' values.

The floodplain roughnesses varied significantly along the extent of the Brisbane and Bremer River systems. Generally, the Manning's 'n' values varied from 0.025 at the Inner Bar, 0.035 for open grassed floodplains, 0.075 for treed floodplains to 0.5 for complete flow retardation in the inner city area.

Hydrographs exported from the RAFTS model were used as direct inputs into the MIKE11 model.

Downstream boundary conditions (tailwater) were based on available data for the Brisbane River. Continuous data from the Bureau of Meteorology was used to set tailwater levels. This allowed tidal influences to be included in the modelling however the quality of the data for the late April 1989 and the May 1996 flood events was considered to be poor and water levels had to be derived to complete each of these data sets.

Each of the floods selected for calibration purposes were simulated using the MIKE11 model. A comparison of recorded and computed flood levels at the gauge and spot level locations is tabulated in **Appendix D - MIKE11 Model Results - Calibration (Table D-1 - Predicted & Recorded Flood Levels for Calibration Events)**. Corresponding discharges are presented in **Table D-2 - Predicted Discharges for Calibration Events**. Longitudinal profiles of peak flood levels for the calibration events are also presented in the **Ipswich Rivers Flood Study Atlas – Calibration Profiles Sheets 42 to 54**.

6.6 December 1991 Flood Event

The December 1991 flood event was assessed for the Bundamba Creek system only, as this was the largest recorded local flood event in recent times. This event was considered to be the primary calibration event for Bundamba Creek because tailwater levels at the Bundamba Creek and Bremer River confluence did not have a significant impact on Bundamba creek hydraulics. The only flood level information for this event was provided at Blackstone Road and Brisbane Road Flood Alert Gauges.

RAFTS inflows were input into the truncated MIKE11 hydraulic model covering Bundamba Creek and roughness parameters were adjusted until a good match between the predicted and recorded stage hydrographs was achieved. Once a good match had been achieved, a discharge consistency check was conducted between the discharge hydrographs predicted by RAFTS and MIKE11. This consistency check ensures that lag link travel time and model storage are correct. This process was repeated until a good calibration was achieved. No recorded runoff volume data was available, therefore, it was not possible to check the predicted runoff volumes directly.

A comparison of recorded and predicted hydrographs is given in **Appendix D Figure D-1 - Predicted & Recorded Hydrograph Comparison - December 1991)**.

Figure D-1 illustrates that a good calibration was achieved between the recorded and predicted flood hydrographs. The rising limb of the hydrograph matches well with the predicted flood levels, matching to within 0.14m and 0.18m of recorded levels at the Blackstone Bridge gauge and Brisbane Road gauges respectively.

The parameters adopted for the Bundamba Creek hydraulic model calibration were then input into the full Ipswich Rivers model and used as a starting set of values during the calibration of the full model.

6.7 January 1974 Flood Event

The January 1974 flood event was the largest flood that has occurred in the Brisbane River System in recent times. This event was considered to be the primary calibration event because a large amount of recorded flood level information was available.

At the time of this flood Wivenhoe Dam had not been constructed and this enabled good calibration of the discharge hydrographs to be achieved.

For this calibration the Merivale Bridge was not included in the model as it was not constructed until 1975. The Cunningham Highway was also not constructed during the 1974 flood event and hence those structures were not included in the hydraulic model.

Due to extensive dredging and shifting of the river bed in the Brisbane and Bremer Rivers it was appropriate to compare surveyed cross sections taken directly after the 1974 flood with more recent surveys and contour plans. A number of cross sections were compared at various locations and although each set of the compared sections were not at an exact corresponding location, the general trend suggested that the river system had a lower bed level (up to 1.5 m). This was not expected to cause significant differences in flood levels as the additional volume, due to the increase in depth, would already be accounted for by the tidal prism. As such, there would only be a small amount of additional conveyance when compared to the total section conveyance at peak flood level.

The Manning's 'n' values were input at each cross section using preliminary values obtained from the site inspection. At bend locations these values were increased by a minimum factor of 1.3 (Chow, 1973) to model the additional losses not accounted for in MIKE11. These parameters were adjusted incrementally until a good calibration was obtained. On completion of this calibration event, generally predicted levels were within 0.1 m of continuous recorded levels and within 0.2 m recorded spot levels.

For continuous records the rise, peak and recession of the hydrographs generally provided a good match to the recorded levels. The recorded spot levels varied significantly depending on whether the level was taken on the outside or inside of a bend. The predicted levels outside the maximum allowable tolerance of 0.2 m were checked and in most cases were deemed to be likely due to superelevation at bends or incorrect recorded level information. This was primarily decided by looking at surrounding levels and identifying any outliers in the recorded levels. In the upper reaches of Brisbane River and Bremer River, higher than expected roughness values were required to achieve recorded levels. This is most likely due to the poor quality of available topographic data in these areas and the model not being able to accurately resolve flooding conditions resulting from the actual topography.

The resulting calibration profile is shown in **Ipswich Rivers Flood Study Atlas Sheets 42 to 54.** A comparison of recorded and predicted hydrographs is given in **Appendix D Figure D-2 - Predicted & Recorded Hydrograph Comparison - January 1974.**

The Manning's 'n' values adopted for this calibration were considered to be slightly higher than expected. This was considered further during other calibration events.

6.8 May 1996 Flood Event

This event was considered to be a small event approximately 10 percent of the size of the 1974 flood in the Brisbane River. Discharge hydrographs calculated by the RAFTS model were used as inflows at each inflow boundary and recorded level information was used as the downstream water level at the downstream boundary. For this event, all hydraulic structures were included in the MIKE11 model.

A range of flood level information was available on a number of creeks and rivers within the bounds of the model. Most of the data was ALERT stage hydrographs.

The Manning's 'n' values obtained from 1974 flood calibration were used for the model run where it was found that the predicted water level at Moggill was well above the recorded water levels. The difference in water levels was so great that the Bureau of Meteorology was contacted to check if a datum shift at the Moggill gauge had been overlooked. This was not the case and further investigations revealed the difference was due to lower bend losses caused by lower flow velocities for the smaller floods.

To check that reducing the Manning's 'n' value was a reasonable assumption a MIKE11 model of one of the Brisbane River bends was set up and a bend loss for three Manning's 'n' values were determined. The three Manning's 'n' values used were:

- 0.07- Value adopted for the 1974 flood at bend.
- 0.05 - Value adopted for the 1996 flood at bend
- 0.035 - Value expected in channel if no bend was present.

The bend loss was considered to be the change in water level from the downstream exit of the bend to the upstream entrance to the bend.

These bend losses were recorded and the following equation was used and a comparison made to check the validity of the adopted roughness values.

Using the bend loss equation:

$$h_b = C_L.V^2/2.g$$

where

$$C_L = 2.b/r$$

and

b = width of flow at bend
r = radius of bend,

the estimated bend losses were calculated for the 1996 flood and the 1974 flood.

The results are presented in Table 6.2: **Comparison of Bend Losses.**

Table 6.2: Comparison of Bend Losses

Flood	b (m)	r (m)	C_L	V (m^3/s)	Calculated h_b (m)	MIKE11 h_b (m)
1996	250	600	0.8	1.2	0.06	0.07
1974	700	600	2.3	1.8	0.39	0.38

It can be seen from Table 6.2 that both the coefficient C_L and the velocity increase significantly at the bend for the larger flood. Since MIKE11 cannot account for bend losses it was therefore necessary to reduce the Manning's 'n' value for the lesser flood to achieve a good calibration.

The rise of the recorded level hydrograph at Moggill matched reasonably well with the predicted rising limb calculated by MIKE11. The predicted peak water level is within 0.230m of the recorded level.

It is suspected that the rating curve at the Moggill Gauge has a poor rating during smaller floods as it is backwater effected from tidal influences at the Western Inner Bar at the mouth of the Brisbane River. The difference is most likely due to the high tidal surge of 1.51 m AHD (almost 0.6 m higher than MHWS tide) during the May 1996 event. The backwater of this tidal surge would have an impact on the reliability of the rating curve at Moggill and therefore the variation in the predicted and recorded flood levels at the Moggill Gauge has been attributed to the tidal backwater effect.

Appendix D - Figure D-3a and D-3b - Predicted & Recorded Hydrograph Comparison - May 1996 illustrates the match of hydrographs achieved.

Recorded flood level data was available at 4 sites along the Bremer River (Percy Street, One Mile Bridge, Hancock Bridge, and Marsden Parade). **Figure D-3a** shows that recorded and predicted data at One Mile Bridge and Marsden Parade were matched to within 100 mm. At Hancock Bridge, the predicted value is approximately 400 mm lower than the recorded data. A better match at this location could potentially be achieved by adjusting the hydraulic bed roughnesses at this location. However, this was not done as the set of bed roughnesses used was seen to represent the best match across all smaller floods modelled in 1983, 1989, 1996.

Results in Bundamba Creek match within 300 mm of recorded data. It was found that predicted levels in Bundamba Creek were generally lower than recorded values. Therefore, the continuing losses in Bundamba Creek were set to 0.8 mm/h compared to the rest of the Bremer River catchment which were modelled in RAFTS using continuing losses of 1.1 mm/h.

It should also be noted that the timing of the peaks along the Bremer River in all the smaller floods, predicted by Mike11, are approximately 6-12 hours early. The reason for this is that the same RAFTS lag times for the Bremer River above the Warrill Creek confluence were used for the 1974 floods and other smaller floods. These lag times were primarily calibrated for the 1974 flood where they would be shorter because flows were faster due to both hydraulic grade and the bypassing of bends (ie. flood plain breakouts).

The results of using the 1974 lag times for all floods is therefore that the predicted peaks for waters downstream of the Warrill Creek confluence occur 6-12 hours before the recorded peaks.

Different lag times could have been derived for the smaller floods, however, all subsequent modelling for the design floods uses the 1974 lags which represent the most conservative case. Therefore developing a separate set of lag times for the smaller floods was not considered necessary.

6.9 Late April 1989 Flood Event

Hydrographs generated by the RAFTS model were used at each inflow location and the adopted Manning's 'n' values used for the 1996 calibration event were used for the calibration of this flood. All bridge structures were included in the MIKE11 model for this calibration.

Available flood level data included some ALERT gauge information on Bremer River, Bundamba Creek and the Moggill and Mount Crosby gauges on Brisbane River.

Table D-1 and Figure D-4a and D-4b – Predicted & Recorded Hydrograph Comparison – April 1989 show the calibration achieved for the 1989 flood event. Matches in the Brisbane River are generally poor at Mount Crosby and Moggill. The fact that this match is poor at Mount Crosby suggests that the synthetically derived BCC Wivenhoe discharge data used could be inaccurate.

Good peak flood level matches were achieved in the Bremer River at One Mile Bridge, David Trumpy and Marsden Parade; all within 200 mm. Sufficient recorded data was not available in Bundamba Ck to confirm the predicted levels.

6.10 June 1983 Flood Event

The Manning's 'n' values adopted for the smaller flood events were used to calibrate the 1983 flood. Wivenhoe Dam had been constructed and all bridge structures were included in the model.

Recorded flood level data was available from ALERT gauges on Bremer River, Woogaroo Creek, Bundamba Creek and the Moggill gauge on Brisbane River.

Table D-1 and Figure D-5a and D-5b - Predicted & Recorded Hydrograph Comparison - June 1983 show an acceptable match between MIKE11 peak predicted levels and levels recorded by the various gauges. The match of predicted flood levels to recorded floods ranged from 0.25m at Marsden Parade to 1 m at One Mile Bridge. While this is considered a significant difference, it is at least conservative. A better match may be achieved for this individual flood by adjusting bed roughnesses, however, the set of parameters used represented the best match across all floods.

In Woogaroo Creek, matches ranged from 0.5 m low to over 1 m high in the lower reaches. **Sheet 53 in the Ipswich Rivers Flood Study Atlas** shows that MIKE11 is higher at the downstream reach of Woogaroo Creek because the recorded values are actually below the backwater level caused by the Brisbane River.
This obviously suggests that levels in the Brisbane River are too high. This is also confirmed at the Moggill gauge when the level is approximately 0.3 m high. This is likely to be caused by inaccuracies in the recorded release data from Wivenhoe Dam.

6.11 Hydrologic and Hydraulic Model Consistency

Due to the absence of stream gauging data on the Brisbane River, direct comparisons between historical hydrographs and calculated RAFTS and MIKE11 hydrographs could not be made. To ensure consistency between the hydrologic and hydraulic models direct comparisons of the calculated hydrographs from each model were made at various locations along the watercourses modelled.

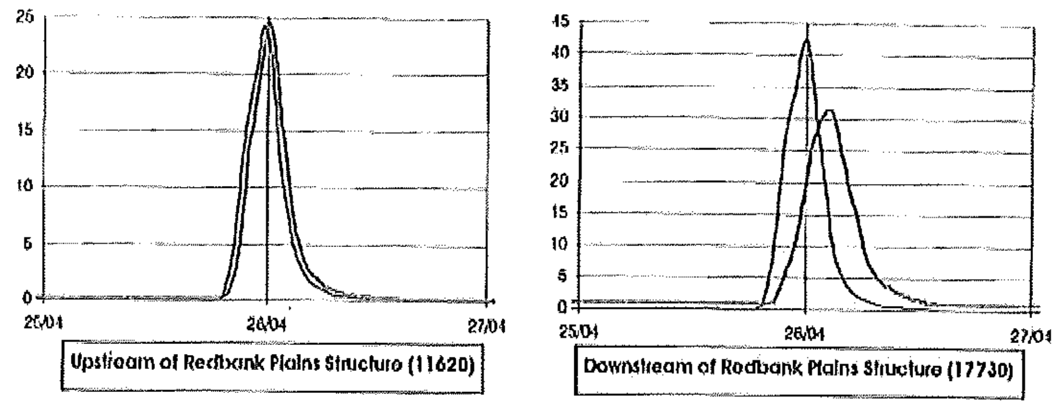
A target of matching consistency between RAFTS and MIKE11 of 10% was achieved in the majority of cases. These comparisons are illustrated in **Appendix E - Hydraulic and Hydrologic Model Consistency.** Exceptions are reported below.

- Bremer River at David Trumpy (1012060) and node 1A (1012060). When the consistency was compared at these locations, MIKE11 was generally found to give lower discharge peaks because of the tidal influence and backwater from the Brisbane River. To account for this 'extra storage' in the MIKE11 model a basin was modelled at David Trumpy in RAFTS. The size of this basin was adjusted until a good match was achieved at David Trumpy across all floods.

  Some experimentation with placing another basin at Node 1A to further reduce RAFTS peaks was undertaken, however, this did not result in achieving a more satisfactory match. Therefore, the reason MIKE11 is generally lower at Node 1A (1023500) than RAFTS is due to backwater and tidal effects from the Brisbane River.

- Predicted Mike11 flows in Six Mile Creek are less than in RAFTS. The cause of this difference was found to be the Redbank Plains Road Crossing structure which tends to attenuate flows. This is illustrated more clearly below in **Figure 6.14 - Effect of Redbank Plains Road Crossing Structure on Six Mile Creek Flows** with discharge hydrographs upstream and downstream of structures.

Figure 6.14: Effect of Redbank Plains Road Crossing Structure on Six Mile Creek Flows



6.12 HEC-RAS Check of Major River Crossings

A check of structure afflux was performed between MIKE11 and HEC-RAS to ensure that head losses across structures were being modelled correctly. This was considered to be an important task as generally MIKE11 over predicts head losses across bridge and culvert structures which causes an over estimation of flood levels upstream of the structure. Structure afflux can be defined as the change in water level between the upstream face of the bridge/culvert and the downstream face of the bridge culvert. The check was conducted by inputting peak discharges from the 1974 flood event into MIKE11 and HEC-RAS and comparing the affluxes predicted by each of the models.

Tailwater levels downstream of each structure were taken from MIKE11 and input into the individual HEC-RAS model developed for each structure. The relevant flow through the structure was input into HEC-RAS and the afflux generated and documented. A comparison of the two results was then performed and the MIKE11 model adjusted until the MIKE11 afflux was within 150 mm (specified tolerance) of the afflux predicted by HEC-RAS.

The results of this structure check are provided below in **Table 6.3: Hydraulic Structure Afflux Check Summary.**

Table 6.3: Hydraulic Structure Afflux Check Summary

No	Structure Location	Chainage (km)	MIKE11 Afflux (mm)	HEC-RAS Afflux (mm)	Difference (m)
Bremer River					
1	One Mile Bridge	1004.600	0.10	0.20	-0.10
2	Wulkuraka Rail Bridge	1006.500	0.11	0.02	0.09
3	Hancock Bridge	1006.400	0.35	0.03	0.32
4	Railway Workshops Bridge	1011.800	0.06	0.12	-0.06
5	David Trumpy Bridge	1012.06	0.03	0.01	0.02
6	Warrego Highway Bridge	1023.500	0.11	0.09	0.02
Brisbane River					
7	Kholo Bridge	979.510	0.06	0.03	0.03
8	Mt Crosby Weir	988.165	Special Weir	Special Weir	Special Weir
9	Colleges Crossing	992.46	0.05	0.15	-0.10
10	Centenary Highway	1028.720	0.15	0.05	0.09
11	Indooroopilly Bridges	1037.110	0.10	0.10	0.00
12	Merivale Bridge	1052.37			
13	William Jolly Bridge	1052.626	0.54	0.61	-0.07
14	Victoria Bridge	1053.355	0.19	0.07	-0.12
15	Captain Cook Bridge	1054.680	0.08	0.10	-0.02
16	Story Bridge	1056.920	0.11	0.04	0.07
17	Gateway Bridge	1068.660	Not modelled	Not modelled	Not modelled
Bundamba Creek					
18	Ripley Road Bridge	18.740	0.24	0.10	0.14
19	Swanbank Road Bridge	25.590	0.02	0.10	-0.08
20	Patrick St Bridge	27.390	0.15	0.23	-0.00
21	Cunningham Highway Bridge & Culverts	28.510	1.04	0.95	0.09
22	Blackstone Road Bridge	31.990	0.09	0.10	-0.01
23	Blackstone Rail Bridge	32..360	0.12	0.12	0.00
24	Brisbane Road Bridge	34.325	0.51	0.06	0.45
25	Basketball Rail Bridge	35.110	0.25	0.28	-0.03
26	Ipswich-Brisbane Rail Bridge	35.530	0.09	0.06	0.03
27	Gledson St Bridge	36.015	0.03	0.07	-0.04
Six Mile Creek					
28	Hallets Road Bridge	10.377	0.07	0.09	-0.02
29	Redbank Plains Rd Crossing	11.785	0.58	0.45	0.13
30	Ipswich Rd Bridge	19.850	0.01	0.01	0.00
31	Six Mile Ck Rail Bridge	20.150	0.02	0.01	0.01

No	Structure Location	Chainage (km)	MIKE11 Afflux (mm)	HEC-RAS Afflux (mm)	Difference (m)
Goodna Creek					
32	Kruger Pde Road Crossing	12.002	1.20	0.28	0.92
33	Ipswich Road Crossing	14.235	0.34	0.32	0.02
34	Goodna Creek Rail Bridge	14.595	0.41	0.45	-0.04
35	Brisbane Tce Road Crossing	14.913	0.01	0.00	0.01
Sandy Creek (Camira)					
36	Addison Rd Crossing	11.051	0.07	0.67	0.00
37	Cochrane St Crossing	11.529	0.31	0.45	-0.14
38	Ishmael St Crossing	12.009	0.44	0.51	-0.07
39	Logan Motorway Crossing	14.720	0.04	0.07	-0.03
Woogaroo Creek					
40	Edna Street Crossing	15.850	0.02	0.02	0.00
41	Ipswich Road Bridge	17.340	0.38	0.24	0.14
42	Woogaroo Ck Rail Bridge	17.450	0.16	0.10	0.06
43	Brisbane Tce Bridge	17.770	0.01	0.01	0.00
Deebing Creek					
44	Brisbane Street	19.837	0.131	0.02	0.111
45	Sandy Gallop No. #5-6	19.122	0.027	0.06	-0.033
47	Sandy Gallop No. #3	18.347	0.061	0.03	0.031
48	Sandy Gallop No. #2	17.923	0.385	0.28	0.105
49	Sandy Gallop No. #1	17.700	0.376	0.47	-0.094
50	Warwick Road Bridge	17.072	0.05	0.02	0.03
51	Ash Street	13.905	0.621	0.40	0.13
52	Cunningham Highway	12.937	0.311	0.1	0.211
Ironpot Creek					
53	Sydney St Bridge	18.375	0.092	0.01	0.082
54	Warrego Highway Bridge	12.641	0.084	0.12	-0.036
55	Walruna Crt Crossing	1.668	1.138	1.11	0.028
Mihi Creek					
56	Hunter St Bridge	11.296	0.514	0.43	0.084
57	Fernvale Rd Bridge	10.728	0.186	0.28	-0.094
58	Pine Mountain Rd Bridge	2.560	0.519	0.64	-0.121
59	Warrego Highway Bridge	1.082	3.846	3.83	0.016
Sandy Creek (Chuwar)					
60	Mt Crosby Road Bridge	12.449	0.113	0.08	0.033
61	Warrego Highway Bridge	11.007	0.237	0.2	0.037

No	Structure Location	Chainage (km)	MIKE11 Afflux (mm)	HEC-RAS Afflux (mm)	Difference (m)
62	Robin Street	10.805	0.618	0.61	0.008

Note: Shaded structures indicate a difference in afflux between Mike11 and HEC-RAS of > 150mm.

From **Table 6.3** it can be seen that generally the structures meet the 150 mm specified tolerance. Structures which exceeded the 150 mm tolerance were checked, however a match was unable to be obtained. Flood profiles for both models were investigated and the most conservative result was adopted.

Each of these HEC-RAS models provide an accurate estimate of headloss through the structure and includes factors such as pier shape and geometry. These models were used to check the MIKE11 approach to modelling structures, using the following methodology:

- The MIKE11 model was run for the 1974 calibration event. Water levels upstream and downstream of the structure and flow discharges were output at the peak of the hydrograph.
- The HEC-RAS model was run using these flow and tailwater conditions. The water levels upstream of the bridge estimated by HEC-RAS were compared against MIKE11 predictions to check if there was a reasonable match between predicted affluxes.

The match achieved at each structure was considered reasonable given the significant differences in the analytical techniques used by MIKE11 and HEC-RAS. The major model differences that contribute to the variation in headloss through the structures are:

- An irregular waterway shape can be specified in MIKE11 which is useful in modelling bridges spanning natural creeks. By comparison, HEC-RAS simplifies the waterway shape as a trapezoid which will introduce a water level difference at flows below the bridge deck.

- Both models assume critical conditions over the bridge deck. However there are considerable differences between the methods employed to determine energy head loss in critical flow. HEC-RAS adopts a standard broad crested weir relationship using an effective weir length (ie. assumes rectangular flow area). MIKE11 uses the critical flow area over the roadway (ie. assumes a variable flow area). The MIKE11 methodology is considered to be a better technique, especially for overtopping of roads that have a complicated longitudinal profile.

The performance of the MIKE11 model to match recorded flood levels (where available) in the vicinity of structures and the consistency of MIKE11 and HEC-RAS results indicates that the MIKE11 model is adequately reproducing structure hydraulics.

6.13 MIKE11 Model Performance

The performance of the hydraulic model over the range of calibration events is considered to be reasonable. Acceptable calibration for this study is considered as matching predicted levels to recorded levels to within the following ranges:

- Continuous records, 0.10 m
- Other flood levels, 0.20 m.

The flood with the most available information was the 1974 flood. All other smaller floods had very few recorded peak levels available for calibration.

Given that the hydraulic parameters established for the 1974 event will be used for design flood calculations, achieving a satisfactory correlation with recorded levels is important. However, the plots of the 1974 flood profiles reveal a large number of inconsistencies both with the predicted flood levels and inconsistencies within the recorded data itself. Therefore achieving a satisfactory calibration relied heavily on a 'best fit' approach and assessing which levels were likely to be outliers.

Examples of problems with the recorded data can be seen clearly on the Bremer River at BREM 1000000-1001000, where recorded levels are significantly below expected values. The reverse situation can again be seen at BREM 1019000-1020000. **(Table D-1** and **Sheet 45** in the **Ipswich Rivers Flood Study Atlas)**.

Another of the effects which has produced differences between recorded and predicted peak levels can be seen on the Brisbane River at BNE 1007000-1008000 (**Table D-1** and **Sheet 44** in the **Ipswich Rivers Flood Study Atlas**. This location coincides with both an inflow from Six Mile Creek and a severe bend. The bend in the creek has the effect of causing superelevation in flood levels on the right side of the river bank (looking downstream). MIKE11 is not capable of accounting for such effects, therefore the model was calibrated to match the average of right and left bank records. At locations such as BNE 1007920 and BNE 1008445 where levels are available for both the left and right bank, the average of the recorded levels lies within 0.2m of the predicted levels.

This bend effect can again be seen at BNE 1010800 where the river bends in the reverse direction to that at Six Mile Creek. At this location a difference of 0.37m can be observed between the right and the left bank recorded levels. Considering the nature of the Brisbane River which contains many bends trying to achieve a match with all predicted levels to within 0.2m is not possible. Hence a line of best fit has been obtained providing a good correlation between predicted and recorded levels.

For the smaller floods, the only recorded flood levels available are those at alert and gauging stations and the calibration to those hydrographs has been discussed previously in this chapter.

Overall, the performance of the hydraulic model is considered acceptable, providing a reasonable representation of the characteristics of the Ipswich Rivers Flood Studies streams and the Brisbane River.

The calibrated model will be suitable for the prediction of design flood levels. The accuracy of the design flood level estimates will be limited by the accuracy of available topographic data.

7. Design Events Hydrology

7.1 Design Storm Requirements

An analysis of design storm events was performed to establish design flood characteristics in the Brisbane River, Bremer River, Warrill Ck, Purga Ck, Deebing Ck, Ironpot Ck, Mihi Ck, Sandy Ck (Chuwar), Bundamba Ck, Six Mile Ck, Goodna Ck, Woogaroo Ck and Sandy Ck (Camira). A range of average recurrence intervals (ARI) from 2 years ARI to the Probable Maximum Precipitation (PMP) were assessed. Temporal patterns and rainfall intensities were based on Australian Rainfall and Runoff 1987 guidelines and hydrologic data supplied by the Department of Natural Resources.

7.2 Catchment Urbanisation

The majority of the Brisbane River Catchment was considered to be rural and was therefore allocated a zero percent impervious. In the Brisbane Metropolitan area the assumed percentage impervious varied from 20 to 50% to account for the catchment urbanisation. Percentage impervious within the bounds of Ipswich City were set using the current extent of urbanisation. These urbanised areas were measured directly off of areal photographs.

7.3 Design Event Rainfall

Design Event rainfall data was required to determine inflow hydrographs for the calculation of flood profiles in the Brisbane River, Bremer River, Warrill Ck, Purga Ck, Deebing Ck, Ironpot Ck, Mihi Ck, Sandy Ck (Chuwar), Bundamba Ck, Six Mile Ck, Goodna Ck, Woogaroo Ck and Sandy Ck (Camira). The distribution of rainfall over the Brisbane River Catchment for the calibration events identified that significant variations of rainfall occurred over the catchment. This variation in rainfall was attributed to the size and topography of the catchment.

Design rainfall intensities were derived using Intensity-Frequency-Duration (IFD) techniques used in Chapter 2 of Australian Rainfall and Runoff 1987 (AR&R). Design rainfall intensities were derived at 130 rainfall gauge locations throughout the catchment to account for the variation of rainfall. Isoheytal rainfall depth maps for the catchment were derived for recurrence intervals ranging from 2 year ARI to 100 Year ARI using the software program 4D and the calculated IFD design rainfalls. Rainfall depths for the 100, 50, 20, 10, 5 and 2 year ARI have not been presented in this report as the rainfall depths vary considerably across each catchment and therefore a single representative rainfall depth is difficult to determine. A rainfall depth can be obtained from RAFTS model results for each catchment and rainfall event if required.

For large catchments it is unlikely that rainfall intensity will remain constant across the catchment. To account for this variation, AR&R suggests use of an areal reduction factor which reduces the depth of rainfall over the catchment.

One of the problems associated with this method is that the areal reduction factor method presented in AR&R is based on work conducted in the United States and to this point virtually no work has been conducted for durations greater than 24 hours or catchments with areas greater than 1 000 km^2. The Department of Natural Resources (DNR) are currently undertaking work in this area however the findings of this report were not available at the time that the design events phase of this study was being assessed. Discussions with DNR have indicated that preliminary findings of their report show that the majority of large floods in the North East Tropical Zone occur after cyclones where rain depressions cause significant flooding. Where this type of rainfall occurs, the spatial variation of rainfall for large catchments is low and areal reduction factors for large catchments are expected to be in the order of 0.95 to 1.00. This theory is supported by Brunt (Hydrology Symposium 1967) who analysed the space-time relations of cyclonic rainfall in the North East Australia.

Since the Brisbane River Catchment is approximately 13 500 km^2 and has a critical duration of approximately 30 hours it was considered that spatial variation would have to be accounted for using an alternate method.

As previously stated design rainfalls were calculated at approximately 130 locations over the entire Brisbane River catchment. These rainfalls were then used to calculate rainfall depths at the centroid of each sub-area (ie approximately 450 locations) using interpolation facilities within 4D. This method ensured that the majority of rainfall variation was accounted for by a blanket coverage of the catchment which in turn minimised the effects of rainfall variation.

Given that the total catchment area of the Brisbane River is approximately 13 500 km^2 and that this area has been broken down into about 450 sub areas, then the average sub area is around 50 km^2. The areal reduction factor for an area of 30 km^2 (24 hour duration) was determined to be 0.98. Since the areal reduction factor was almost equal to one, areal reduction factors were not applied to any of the sub-areas. The rainfall intensities used in this study are therefore considered to be slightly conservative.

To be consistent, areal reduction factors have not been applied to the smaller catchments such as Bremer River, Bremer River Tributaries and Brisbane River Tributaries. Again this is a conservative approach however due to the methodology that has been adopted to determine loss rates, the resulting runoff is only considered slightly conservative. This methodology will be discussed in more detail in **Section 7.6** of this report.

Australian Rainfall and Runoff temporal patterns for zone 3 apply to the Brisbane River Catchment.

The Probable Maximum Precipitation (PMP) rainfall depth and corresponding temporal patterns for the Brisbane River & Bremer River catchments were provided by the Bureau of Meteorology for the DNR study. The adopted PMP rainfall depth for the Brisbane River and Bremer River Catchments are presented in **Table 7.1 - PMP Rainfall Depths - Brisbane River & Bremer River Catchments.**

Table 7.1 - PMP Rainfall Depths - Brisbane River & Bremer River Catchments

Duration	Brisbane River Catchment PMP Rainfall Depth (mm)	Bremer River Catchment PMP Rainfall Depths (mm)
6	200	340
12	370	610
24	530	880
48	680	1260
72	830	1580
96	1010	1830
120	1050	1000
144	1070	1040
168	1100	2140

Note: Generalised Tropical Storm Method (GTSM) was used to calculate rainfall depths.

The Probable Maximum Precipitation (PMP) rainfall depth and corresponding temporal patterns for the Purga Creek, Deebing Creek, Ironpot Creek, Mihi Creek, Sandy Creek (Chuwar), Bundamba Creek, Six Mile Creek, Goodna Creek, Woogaroo Creek and Sandy Creek (Camira) Catchments were calculated using methods in Bulletin 53 - The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method (Dec 1994). The methodology in Bulletin 53 is appropriate for catchments of area less than 1000 km^2 and critical durations of less than 6 hours. The adopted PMP rainfall depth for the Warrill Creek Catchment is presented in **Table 7.2: PMP Rainfall Depths, Purga Creek, Deebing Creek, Ironpot Creek, Mihi Creek, Sandy Creek (Chuwar), Bundamba Creek, Six Mile Creek, Goodna Creek, Woogaroo Creek and Sandy Creek (Camira) Catchments.**

Table 7.2: PMP Rainfall Depths, Purga Creek, Deebing Creek, Ironpot Creek, Mihi Creek, Sandy Creek (Chuwar), Bundamba Creek, Six Mile Creek, Goodna Creek, Woogaroo Creek and Sandy Creek (Camira) Catchments

Duration (hrs)	Purga (mm)	Deebing (mm)	Ironpot (mm)	Mihi (mm)	Sandy (Chuwar) (mm)	Bundamba (mm)	Six Mile (mm)	Goodna (mm)	Woogaroo (mm)	Sandy (Camira) (mm)
0.25	120	150	160	170	170	130	150	160	140	140
0.50	170	220	230	250	240	190	220	230	200	210
0.75	210	290	300	320	310	240	280	290	260	270
1.0	260	340	350	370	360	290	330	340	310	320
1.5	340	430	440	470	410	370	420	440	400	370
2.0	380	500	520	550	460	420	490	510	460	410
2.5	430	550	570	600	500	460	540	560	520	440
3.0	470	600	620	660	520	520	590	610	560	460
4.0	530	680	710	710	570	590	670	690	630	520
5.0	570	750	780	820	620	640	730	760	690	560
6.0	610	790	820	870	650	680	780	810	740	590

The Probable Maximum Precipitation (PMP) rainfall depth and corresponding temporal patterns for the Warrill Creek Catchment was calculated using methods in Australian Rainfall and Runoff (1998) Book VI-Estimation of Large to Extreme Floods. The methodology in Book VI is appropriate for catchments of area greater than 1000 km^2 and critical durations of greater than 6 hours. The adopted PMP rainfall depth for the Warrill Creek Catchment is presented in **Table 7.3: PMP Rainfall Depths, Warrill Creek Catchment.**

Table 7.3: PMP Rainfall Depths, Warrill Creek Catchment

Duration (hrs)	Warrill Creek Catchment PMP Rainfall Depths (mm)
6	403
12	655
24	927
48	1323
72	1622
96	2014

The procedural method for the GTSM and the GSDM is provided in **Appendix F - Probable Maximum Precipitation Methods.** Spatial variation for the PMP events was accounted for by use of Figure F-1 - Generalised Tropical Storm Method Design Isohyetal Pattern for the Distribution of PMP over Areas > 2 000 km^2, Figure F-2 - Generalised Tropical Storm Method Design Isohyetal Pattern for the Distribution of PMP for Areas <= 2 000 km^2 and Figure F-3 - Generalised Short Duration Method Spatial Distribution. These figures are presented in **Appendix F.**

7.4 Flood Frequency Analysis

The flood frequency information for the Ipswich Rivers Flood Studies was determined using information obtained from two previous studies, these were:

- Brisbane City Council (BCC)
- Sinclair Knight Merz (SKM).

7.4.1 Brisbane City Council Flood Frequency Analysis

The Brisbane City Council supplied flood frequency information for the Port Office Gauge. This information was provided in the form of a draft report and may not reflect the final adopted values accepted by the Brisbane City Council. This report was supplied on the provision that its findings would not be made public until the Brisbane City Council had accepted the findings.

The flood frequency analysis provided by Brisbane City was based on the flood frequency analysis conducted by Sinclair Knight Merz for the Brisbane River Flood Study. The revised flood frequency analysis (BCC) investigated the effects that dredging and a bar at the mouth of the Brisbane River would have on flood levels and discharges at the Port Office Gauge.

The revised BCC flood frequency analysis was conducted for a period of record spaning 155 years (1841 to 1996). The period of record was divided into 3 individual periods which reflected the river conditions throughout the entire 155 year period. These periods were:

- 1841 to 1861 – record adjusted by -0.4 m to account for the removal of a bar at the mouth of the Brisbane River prior to 1864.
- 1861 to 1917 – record adjusted by -1.52 m to account for the dredging of the lower Brisbane River prior to 1917.
- 1919 to 1996 – current Brisbane River conditions.

For floods prior to 1861 a total of 1.92 m was subtracted from the recorded flood levels. Between 1861 and 1917 a toal of 1.52 m was subtracted from recorded flood levels. No adjustment was made to flood records after 1917. These assumptions were based on work conducted by BCC.

A review of these assumptions found that while these reductions are considered appropriate at the Port office Gauge, these assumptions have a major impact on flood levels and discharges at the Moggill Gauge. The assumptions used by the Brisbane City Council significantly under estimated flood levels and discharges and therefore a flood frequency analysis for the Moggill Gauge site was undertaken.

7.4.2 Sinclair Knight Merz Flood Frequency Analysis

A flood frequency analysis was performed at the following four sites:

- Brisbane River at Moggill
- Warrill Creek at Amberley
- Purga Creek at Loamside
- Bremer River at David Trumpy Bridge, Ipswich

Information about these sites and the records available are summarised in **Table 7.4: Data Available for Frequency Analysis**.

Table 7.4: Data Available for Frequency Analysis

Station	Catchment Area (km^2)	Period of Record	Continuous Annual Series
Moggill BVRT 040545 Moggill TM 040819 Moggill Alert 040812	12 700	1893 – 1999	Nil
143108 Warrill Ck at Amberley	920	1961 – 1998	1961/62 to 1997/98
143113 Purga Ck at Loamside	215	1973 – 1998	1973/74 to 1997/98
40831 Bremer River at David Trumpy Bridge at Ipswich	1 850	1893 – 1999	Nil

The Moggill Gauge site on the Brisbane River is a flood warning station only and gauge observations are made only when the river levels are high. As flooding does not often occur on a yearly basis, the record is discontinuous. In order to account for floods that were not recorded at Moggill, the Moggill Gauge record has been supplemented by using information measured at the Port Office Gauge. The Port Office gauge is located approximately 50 km downstream from the Moggill Gauge on the Brisbane River.

The site on Bremer River at David Trumpy Bridge is a flood warning station only. Gauge observations are made only when the river is at high (flood) stage. As this does not occur every year, the record is discontinuous. The frequency of observations also appears to have changed over the years, or at least the threshold above which observations are made appears to have changed *c.*1960. Prior to that date, all observations exceed 8.9 m, but there are many observations below this level post-1960. Post-1960, all observations of peaks are greater than 5.3 m.

This site is also affected by backwater from the Brisbane River. No discharge data was obtained, but the discharge rating for this site would be unreliable because of the significant backwater influence. Frequency analysis for this site was therefore performed on river stage, not discharge.

The flood frequency analysis for the David Trumpy Bridge site was conducted over a period ranging from 1893 to 1999. Within this period both Somerset Dam and Wivenhoe dam were constructed and since the David Trumpy gauge is effected by backwater, levels at this site will be effected by the construction of these dam structures. Unfortunately there is no direct correlation between Brisbane River flooding and Bremer River flooding and hence no adjustment can be made to modify the David Trumpy record to account for the introduction of the dams. This site can therefore only be used as an indicative check when analysing loss rates within the RAFTS hydrological model.

The site on Purga Creek at Loamside can also be affected at high stage by backwater from Warrill Creek, of which it is a tributary. The site is a short distance upstream of the confluence, not well confined at high stage and during high floods floodwaters can extend across the floodplain between the two streams. Measurement of discharges becomes difficult at flood stage, and so the discharge rating relies heavily upon extrapolation from the low to medium stage range. The discharge rating for this site is therefore also subject to considerable error. The Amberley gauge and Loamside gauge records have not been effected by the introduction of Wivenhoe and Somerset Dams.

Previous modelling work using the RAFTS rainfall-runoff model consistently over-estimated flood peaks in major floods when using a parameter set which worked well for most catchments in the region (SKM, June 1998). This suggests that the high flood stage discharge rating at this site may be low.

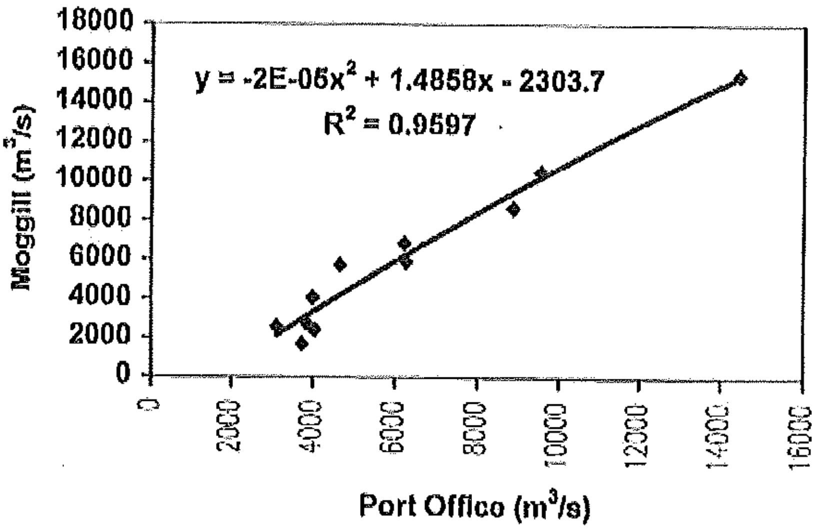
Frequency Analysis
Analysis was undertaken using the log Pearson type 3 distribution fitted according to the methods recommended in (Institution of Engineers, Australia, 1987).

For the incomplete series for the Brisbane River, several adjustments were made to the Moggill record to include floods prior to 1890. These floods were considered to be important as they represented the large to intermediate flood range.

Discharges were determined from the recorded flood level information at the Moggill and Port Office Gauges using the SKM rating curve and the Bureau of Meteorology rating curve (0.15m AHD) respectively. No adjustment was made to the record to account for dredging or the removal of the Western Inner Bar. A review of the Brisbane City Council Flood Frequency Analysis indicated that changes in the downstream river conditions (with respect to the removal of the bar and dredging) did not have a major effect on the flood levels at Moggill for the medium to large flood events.

Using the flow data a correlation between Port Office and Moggill was conducted using corresponding flood events at the two sites. The results of this data correlation are presented in **Figure 7.1: Flow Correlation Between Moggill Gauge and Port Office Gauge.**

Figure 7.1: Flow Correlation Between Moggill Gauge and Port Office Gauge

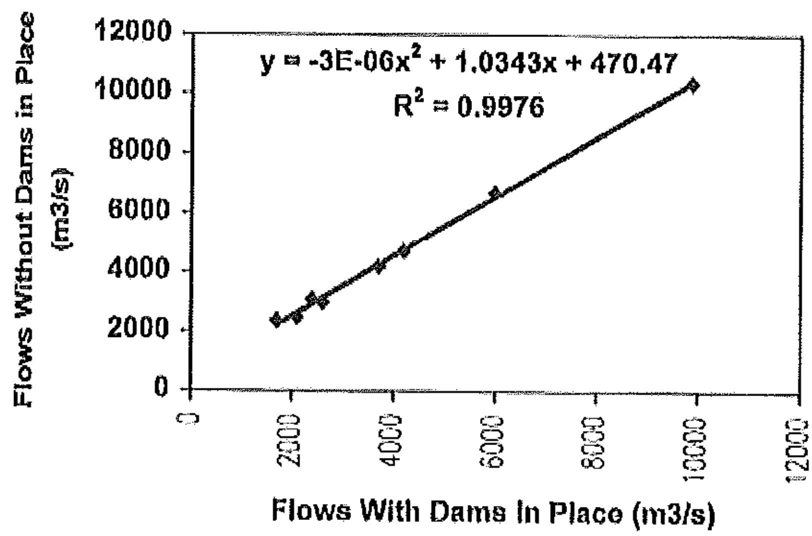


Good agreement was achieved, with the relationship producing a 96% correlation between the Port Office and Moggill flows. This relationship between the Port Office flows and Moggill flows was developed and applied to the Port Office record prior to 1893. These adjusted Port Office values were added to the Moggill record for the analysis. Note that care should be taken with flows above 10 000 m^3/s as there is limited recorded data outside this range. The correlation determined in **Figure 7.1** may not reflect the real relationship between the two sites above a discharge of 10 000 m^3/s.

Floods recorded at the Port Office site but not recorded at Moggill between 1983 and 1996 were included in the analysis. Flows predicted at the Port Office were used to supplement the Moggill record within this period.

Once the composite record at Moggill had been established, the record had to be adjusted to account for the introduction of Wivenhoe and Somerset Dams. This was achieved by using the Brisbane City Council Flood Frequency Analysis. BCC had adjusted the record to remove the influences of Wivenhoe and Somerset Dams post 1943. An analysis was conducted to develop a relationship between flows in the Brisbane River post 1943, with and without the dams in place. This relationship is presented in **Figure 7.2: Flow Correlation in the Brisbane River Between Dams and No Dams Case.**

Figure 7.2: Flow Correlation in the Brisbane River Between Dams and No Dams Case



A good correlation was achieved and the developed relationship was applied to the discharges at Moggill after 1943 to reflect the No Dams discharges at Moggill Gauge in the Brisbane River.

A flood frequency analysis was performed at the Moggill Gauge using the composite data set described above. Flows below 2000 m^3/s were excluded from the analyses as these flows are dependent on tidal conditions at the mouth of the Brisbane River. These variations in tides would have an impact on the analysis and hence only floods above the 2000 m^3/s threshold have been included.

For the incomplete series at David Trumpy Bridge (Bremer River), adjustment of theoretical plotting probability was made using the method described in Section 10.7.2 of Australian Rainfall and Runoff. This is method applies when zero or very low flows are to be excluded. The method can also be used for data series which include only floods above a threshold, although greater accuracy is achieved when only zero or very low flows are excluded. Floods above a threshold were available for only 29 of 107 years of record.

For the complete annual series at Amberley and Loamside, very low annual maxima were excluded using the adjustment described in section 10.7.2 of Australian Rainfall and Runoff. In the case of Warrill Creek, data for 3 years with very low maxima were excluded (for years 1985/86, 1986/87 and 1994/95). For Purga Creek, data for 7 years with very low maxima were excluded (for years 1985/86, 1986/87, 1992/93, 1993/94, 1994/95, 1996/97 and 1997/98).

Results

Results of the frequency analysis are presented in the following tables:

- **Table 7.5: Flood Frequency Estimates, Brisbane River at Moggill - No Dams in Place**
- **Table 7.6: Flood Frequency Estimates, Warrill Creek at Amberley**
- **Table 7.7: Flood Frequency Estimates, Purga Creek at Loamside**
- **Table 7.8: Flood Frequency Estimates, Bremer River at David Trumpy Bridge, Ipswich.**

Table 7.5: Flood Frequency Estimates, Brisbane River at Moggill - No Dams in Place

AEP	ARI (y)	Discharge (m^3/s)	95% Confidence Limits	
50%	2	1187	883	1595
20%	5	2595	1849	3643
10%	10	5522	3644	8367
5%	20	7886	4668	13322
2%	50	11145	5538	22429
1%	100	13843	5938	32272
		Skewness coefficient = 0.24		

Table 7.6: Flood Frequency Estimates, Warrill Creek at Amberley

AEP	ARI (y)	Discharge (m^3/s)	95% Confidence Limits	
50%	2	173	125	239
20%	5	445	309	641
10%	10	747	485	1 150
5%	20	1 150	673	1 955
2%	50	1 865	928	3 750
1%	100	2 585	1 115	5 070
		Skewness coefficient = 0.04		

Table 7.7: Flood Frequency Estimates, Purga Creek at Loamside

AEP	ARI (y)	Discharge (m^3/s)	95% Confidence Limits	
50%	2	44	23	86
20%	5	159	94	269
10%	10	202	130	313
5%	20	267	156	458
2%	50	364	179	739
1%	100	447	191	1 045
		Skewness coefficient = 0.05		

Table 7.8: Flood Frequency Estimates, Bremer River at David Trumpy Bridge, Ipswich

AEP	ARI (y)	Stage (m)
50%	2	3.62
20%	5	8.47
10%	10	11.24
5%	20	13.55
2%	50	16.44
1%	100	18.60
	Skewness coefficient = 0.17	

The results for Purga Creek at Loamside should be treated with caution. Greater confidence is placed in the discharge rating for Warrill Creek at Amberley. The ratio of Q_{100} / Q_{10} for this site is 3.46.

The same ratio for the results from Purga Creek is only 2.21. This is a substantially different growth factor for flood frequency from two sites within the Warrill Creek catchment, and lends to suspicion that the discharge rating at high flood stage for the Purga Creek site is too low.

If it were assumed that Q_{10} was estimated with reasonable accuracy at Purga Creek, and that the same growth factor applied as at the Warrill Creek site, this would lead to an estimate of Q_{100} for Purga Creek of 699 m^3/s. This may not be a very reliable assumption as the highest recorded flow at the site is 47 m^3/s.

The reliability of the flood frequency estimates for the 2 year and 5 year ARI floods on the Brisbane River is questionable due to the removal of flows less than 2 000 m^3/s.

Despite the low percentage of years for which flood data were available from the Bremer River site, the results obtained are regarded as reasonably reliable. The accuracy could have been improved had data been available from more years, but reasonable accuracy is likely for the lower AEPs since the period of record spans 107 years. This location provides a true representation of flooding occurring at the site from both Bremer River and Brisbane River flooding.

Figure 7.3: Flood Frequency Analysis, Brisbane River at Moggill – No Dams In Place shows the plotted data and the fitted log Person type 3 distribution for the Brisbane River (No dams in place). Flows less than 2000 m^3/s have been omitted.

Figure 7.3: Flood Frequency Analysis, Brisbane River at Moggill – No Dams In Place

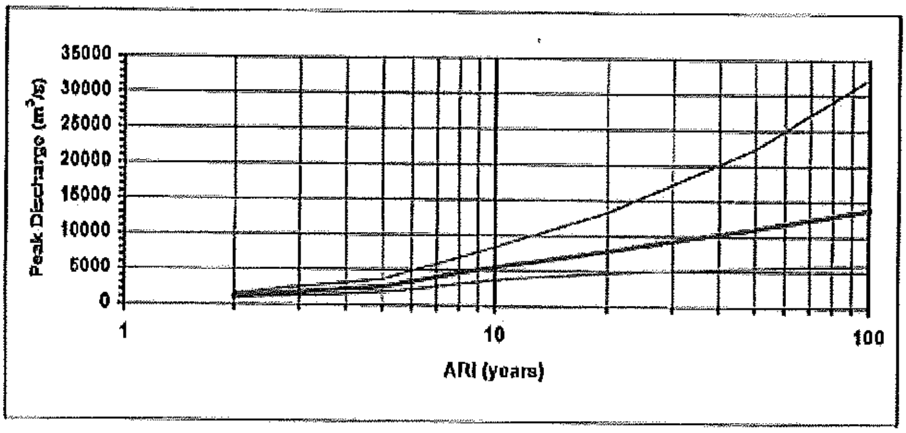


Figure 7.4: Flood Frequency Analysis, Warrill Creek at Amberley shows the plotted data and the fitted log Person type 3 distribution for Warrill Creek. In the lower half of the diagram the 3 data items for years of very low flows were omitted.

Figure 7.4: Flood Frequency Analysis, Warrill Creek at Amberley

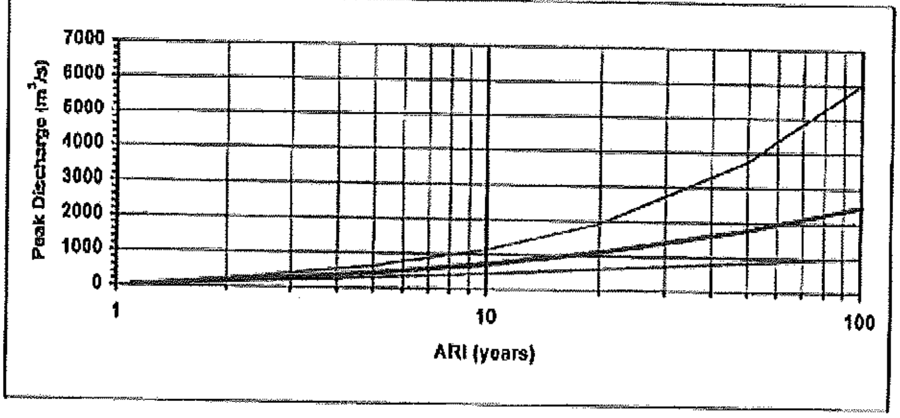


Figure 7.5: Flood Frequency Analysis, Purga Creek at Loamside shows the plotted data and fitted probability distribution for Purga Creek with data from the 7 years of very low flows omitted.

Figure 7.5: Flood Frequency Analysis, Purga Creek at Loamside

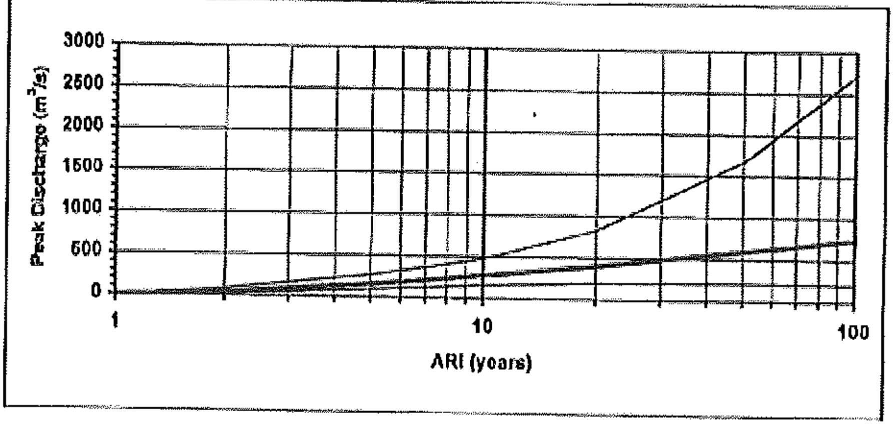
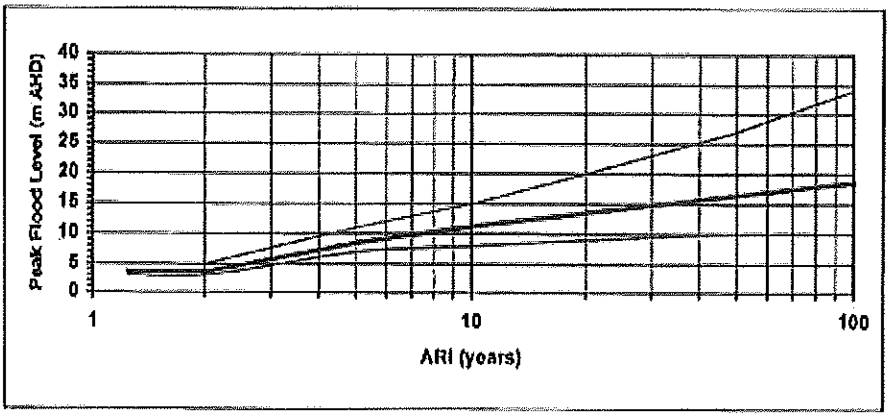


Figure 7.6 Flood Frequency Analysis, Bremer River at David Trumpy Bridge, Ipswich shows the plotted data and fitted probability distribution for the peak stage data at David Trumpy Bridge on the Bremer River.

Figure 7.6 Flood Frequency Analysis, Bremer River at David Trumpy Bridge, Ipswich



7.5 Wivenhoe and Somerset Dam Operations

During the Design Events Phase of the studies a debriefing session with the South East Queensland Water Board was held to discuss dam operations for Somerset and Wivenhoe Dams for the February & March 1999 floods. This discussion was particularly relevant to determining appropriate dam operations for this study.

The return period of the February 1999 storm event was determined to be somewhere between 20 to 50 year ARI for various locations in the Upper Brisbane Catchment. The March 1999 flood event was much smaller in magnitude and therefore the following discussion will relate to the February event.

One of the most important factors with regard to dam operations was that once both dams reached full supply level, valves were opened and releases began. This meant that little flood mitigation storage was used in the dam before releases occurred. The releases were controlled such that flooding of downstream bridges (ie. Fernvale Bridge, Burtons Bridge, Kholo Bridge and Mt Crosby Weir Bridge) were not overtopped. This was a complex procedure and was controlled by people actually measuring and reporting flood levels at the bridge sites to the dam operators to ensure that the releases were not causing any of the bridge structures to be overtopped.

It should be realised that these floods were predominantly upper Brisbane River floods and that virtually no flooding of Lockyer Creek (downstream of Wivenhoe Dam) occurred. If Lockyer Creek flooding was to occur simultaneously with the Upper Brisbane River flooding a completely different dam release procedures would most likely result.

Given the complexity and human interaction in this process, these dams operations were not able to be modelled in the RAFTS hydrological model. Therefore, a simplistic model was adopted. For the Brisbane River Flood Study a height-maximum discharge relationship was adopted for both dams. At the time the release model adopted for the Brisbane River Flood Study was considered to be reasonably conservative, however actual dam release operations for the February 1999 event indicate that they may not be as conservative as first thought.

As previously stated, for the February 1999 flood event, once both dams reached full supply level, spillway gates and valves were opened and dam releases commenced. This is consistent with the approach adopted in the Brisbane River Flood Study release model. Although the releases were controlled in order to reduce flooding of the downstream bridge structures it must be remembered that Lower Brisbane, Bremer and Lockyer Creek flooding was minimal and an entirely different set of release procedures would have been adopted.

To assist in the operational dam releases of Wivenhoe and Somerset Dams a set of operational procedures has been developed by the South East Queensland Water Board (SEQWB). These procedures are set down in the 'Manual of Operational Procedures for Flood Mitigation for Wivenhoe Dam and Somerset Dam (Nov 1997)'. The purpose of the manual is to define procedures for the operation of Wivenhoe Dam and Somerset Dam to reduce downstream flooding where possible without endangering the structural integrity of the Dams. Where possible the community is to be protected against flooding hazards. The following objectives of the manual are listed below in descending order of importance:

- Ensure the structural safety of the dams.
- Provide optimum protection of urbanised areas from inundation.
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers and their major tributaries.
- Minimise disruption and impact upon Wivenhoe Power Station.
- Minimise disruption to navigation in the Brisbane River.

Given that the Trust's main objective is flooding within the Ipswich Area, the last two points in the above list have not been considered in this report.

Wivenhoe Dam is predominantly a central core rock fill dam and is not resistant to overtopping. Should Wivenhoe Dam be overtopped during a flood event structural failure of the dam could occur. This failure would have catastrophic consequences for all downstream areas and in particular would have significant flooding impacts within the Ipswich Area.

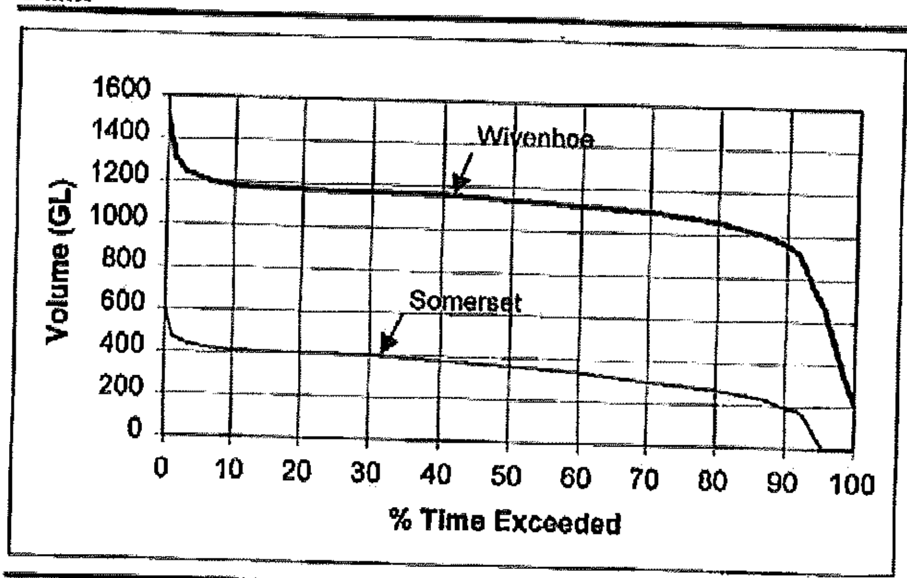
Somerset Dam is a mass concrete dam which can withstand limited overtopping however failure of these structures occur suddenly without warning. Wivenhoe Dam has the capacity to mitigate the flooding effects should Somerset Dam fail, however should this failure occur during a significant flood event, Wivenhoe Dam could be overtopped and also destroyed.

Given this scenario it is therefore of paramount importance that operational procedures reflect that the dams should not be overtopped.

This importance of the structural integrity of the dams was reinforced by the Dam Operations Engineers as they were of the opinion that if they were even remotely concerned about the safety of the dams full release procedures would be adopted. Full release procedures are also to be employed if radio and telephone communications are cut to the dams and during the February 1999 event some communication difficulties were experienced.

A set of storage performance curves for Wivenhoe and Somerset Dams. Storage Performance Curves for Wivenhoe and Somerset Dams were provided by the South East Queensland Water Board. The storage performance investigations were carried out by the Department of Natural Resources. The results from this investigation are presented in **Figure 7.7: Storage Performance Curves for Wivenhoe & Somerset Dams.**

Figure 7.7: Storage Performance Curves for Wivenhoe & Somerset Dams



The full supply volume (FSV) for the Wivenhoe Dam is 1165.2 GL and the FSV for Somerset Dam is 379.85 GL. Using this information and **Figure 7.7** a summary of the probability of the full supply volume of each dam being exceeded is presented in **Table 7.9: Exceedence Probability of Full Supply Volume of Wivenhoe & Somerset Dams Being Exceeded.**

Table 7.9: Exceedence Probability of Full Supply Volume of Wivenhoe & Somerset Dams Being Exceeded

Wivenhoe Dam			Somerset Dam		
Volume (GL)	% Full (%)	% Time Exceeded (%)	Volume (GL)	% Full (%)	% Time Exceeded (%)
1165.2	100	20	379.9	100	40
1048.7	90	80	341.9	90	70
932.2	80	92	303.9	80	75
582.6	50	97	190.0	50	91

From **Table 7.9** it can be seen that full supply volumes are exceeded 20 out of 100 years for Wivenhoe Dam and 40 out of 100 years for Somerset Dam however 90% of the full supply volume for Wivenhoe and Somerset Dams is exceeded 80 out of 100 years for Wivenhoe Dam and 70 out of 100 years for Somerset Dam.

The above probability of exceedence shows that there is a large chance that both dams will be full or 90% full at the time of a major storm event. It is also recognised that previous major storm events have occurred during significant rain depressions and that the dams have been full at the time of the major storms.

From our investigations into the dam operations procedures and discussions with the Ipswich Rivers Improvement Trust the following dam operations have been adopted for this study:

- Emergency dam release procedures for both Wivenhoe and Somerset Dams have been assumed. This procedure is still slightly conservative however this will provide the most realistic approach that can be confidently predicted within the Ipswich Rivers RAFTS hydrological model. This approach will also be consistent with the Brisbane River Flood Study.

- The starting water levels for both dams are assumed to be Wivenhoe RL 67.0 m AHD and Somerset RL 100.5 m AHD which is full supply level and spillway level respectively. It should be noted that initial dam levels for Wivenhoe Dam and Somerset Dam were assumed to be at full supply level for the Brisbane River Flood Study.

7.6 Initial and Continuing Losses

Initial and continuing losses were determined by matching the peak discharges predicted by RAFTS and the peak discharges predicted by the flood frequency analysis sites at the Moggill Gauge (Brisbane River), Amberley Gauge (Warrill Creek) and Loamside Gauge (Purga Creek). Note that the Moggill Gauge analysis was conducted using the no dams in place flood frequency results.

The critical duration storms for return periods ranging from 2 years ARI to 100 years ARI were determined assuming 0 mm initial loss and 0 mm/hr continuing loss for the Brisbane River, Warrill Creek and Purga Creek. Once a critical duration had been determined for each river/creek, initial and continuing losses were applied to the RAFTS model until a good match between the flood frequency peak discharges and the RAFTS peak discharges was achieved. Once a good match was achieved, a check was conducted to determine if the initial estimate of the critical duration was still applicable. This method was undertaken as an iterative process until final critical durations and peak discharges were determined.

A comparison between the peak discharges for the Flood Frequency Analysis and the RAFTS model with determined losses applied are presented in:

- Table 7.10: Comparison of Peak Discharges for Flood Frequency and RAFTS – Moggill Gauge, Brisbane River
- Table 7.11: Comparison of Peak Discharges for Flood Frequency and RAFTS – Amberley, Warrill Creek
- Table 7.12: Comparison of Peak Discharges for Flood Frequency and RAFTS – Loamside Gauge, Purga Creek.

Table 7.10: Comparison of Peak Discharges for Flood Frequency and RAFTS – Moggill Gauge, Brisbane River

ARI (years)	Critical Dur (hrs)	RAFTS (m3/s)	FFA (m3/s)	% diff	I.L (mm)	C.L (mm/hr)
100	30	13732	13843	-1	0	0.5
50	30	11217	11145	+1	0	1.0
20	30	8245	7888	+4	0	1.5
10	30	5756	6522	+4	25	2.5
5	30	2995	2595	+13	70	3.0
2	30	1214	1187	+2	70	3.0

Table 7.10 shows that generally the flood frequency peak discharges match the RAFTS peak discharges to within 4%. The 5 year ARI flood event agrees to within 13%. This is considered acceptable due to the low reliability of the lows flows predicted in the Brisbane River by the flood frequency analysis.

Table 7.11: Comparison of Peak Discharges for Flood Frequency and RAFTS – Amberley, Warrill Creek

ARI (years)	Critical Dur (hrs)	RAFTS (m^3/s)	FFA (m^3/s)	% diff	I.L (mm)	C.L (mm/hr)
100	18	2577	2585	0	0	1.5
50	18	1904	1805	+2	20	2.0
20	18	1178	1150	+2	40	2.5
10	18	750	747	0	55	2.5
5	18	423	445	-5	70	2.5
2	18	199	173	15	70	2.5

Table 7.11 shows that generally the flood frequency estimates and the RAFTS estimates generally agree to within 5%. As Warrill Creek catchment makes up approximately four fifths of the Bremer River Catchment, and that both systems have the same critical duration time of 18 hours, loss parameters adopted for Warrill Creek were applied to the Bremer River.

Table 7.12: Comparison of Peak Discharges for Flood Frequency and RAFTS – Loamside Gauge, Purga Creek

ARI (years)	Critical Dur (hrs)	RAFTS (m^3/s)	FFA (m^3/s)	% diff	I.L (mm)	C.L (mm/hr)
100	4.5	1372	447	+207	0	1.5
50	4.5	939	364	+158	20	2.0
20	18	453	267	+70	40	2.5
10	18	338	202	+67	55	2.5
5	18	183	159	+15	70	2.5
2	18	47	44	+7	70	2.5

From Table 7.12 it can be seen that the flood frequency peak discharges and the RAFTS model peak discharges differ significantly. The loss rates applied to the Purga Creek Catchment were the same as those applied to the Warrill Creek Catchment. While these losses were considered to be acceptable for the Warrill Creek Catchment, they were considered high for the Purga Creek Catchment. This assumption was reinforced by the fact that that the critical duration changes from 4.5 hours to 18 hours for floods below the 50 year ARI events.

The poor results obtained for the Purga Creek Catchment was attributed to the reliability of the rating curve at the site and hence, the results obtained from the flood frequency analysis at Loamside were not considered further.

The unreliability of the flood frequency estimate at Purga Creek presented a problem to determine losses for the Bremer and Brisbane Rivers tributaries. As Purga Creek has a catchment size similar to the Bremer and Brisbane River tributaries, it was assumed that the losses determined for Purga Creek would be used for the tributaries. As the losses identified in **Table 7.12** were clearly not acceptable due to the large change in critical duration, another alternative was devised.

The Brisbane City Council have completed a flood study on Sandy Creek (Camira) and the upper extent of the Sandy Creek (Camira) model corresponds to the downstream end of Sinclair Knight Merz model (i.e. Logan Motorway). The Brisbane City Council model has been calibrated and hence a set of flows and losses were available. Unfortunately, the BCC used a different loss model to that used in the Ipswich Rivers Flood Studies and this meant that direct use of the BCC loss parameters was not possible. Flows predicted at the top end of the BCC model were however able to be matched by varying loss rates in the Ipswich Rivers Model. **Table 7.13: Comparison of Peak Discharges for Flood Frequency and RAFTS – Ipswich Motorway, Sandy Creek (Camira)** presents the results from this analysis.

Table 7.13: Comparison of Peak Discharges for Flood Frequency and RAFTS – Ipswich Motorway, Sandy Creek (Camira)

ARI (years)	Critical Dur (hrs)	RAFTS (m^3/s)	BCC (m^3/s)	% diff	I.L (mm)	C.L (mm/hr)
100	1.5	159	157	+1	5	2.5
50	1.5	130	125	+4	10	2.5
20	3	97	95	+2	15	2.5
10	3	78	78	0	15	2.5
5	3	63	63	0	15	2.5
2	2	41	48	-15	15	2.5

Table 7.13 shows that generally the comparison is within 5%. These losses were considered to be much more acceptable for catchments ranging from 10 km^2 to 250 km^2. These losses were therefore adopted for Purga Creek and the remainder of the tributaries.

A summary of the loss parameters adopted for the Ipswich Rivers Flood Studies is presented in **Table 7.14: Summary of Adopted Loss Parameters - Ipswich Rivers Flood Studies.**

Table 7.14: Summary of Adopted Loss Parameters - Ipswich Rivers Flood Studies

River/Creek Name	100 Year ARI		50 Year ARI		20 Year ARI		10 Year ARI		5 Year ARI		2 Year ARI	
	I.L (mm)	C.L (mm/h)	I.L (mm)	C.L (mm/h)	I.L (mm)	C.L (mm/h)	I.L (mm)	C.L (mm/h)	I.L (mm)	C.L (mm/h)	I.L (mm)	C.L (mm/h)
Brisbane	0	0.5	0	1.0	0	1.5	25	2.5	70	3.0	70	3.0
Bremer	0	1.5	20	2.0	40	2.5	55	2.5	70	2.5	70	2.5
Warrill	0	1.5	20	2.0	40	2.5	55	2.5	70	2.5	70	2.5
Purga	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Sandy (Camira)	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Woogaroo	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Goodna	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Six Mile	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Sandy (Chuwar)	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Bundamba	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Mihi	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Ironpot	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5
Deebing	5	2.5	10	2.5	15	2.5	15	2.5	15	2.5	15	2.5

The loss parameters adopted for this study range between 0 and 70 mm for initial losses and 0.5 and 3.0 mm/h for continuing losses. These loss rates are considered to be within acceptable limits as they all fall within the bounds of loss rates determined as part of the calibration phase of this report (see **Table 5.17**).

Due to the nature of the rain depressions which cause extreme flood events in South East Queensland, adopted loss parameters for the 200 year ARI, 500 year ARI and PMP flood events are:

- Initial loss = 0 mm
- Continuing Loss = 0 mm/hr.

These parameters relate to all tributaries included in Phases 1 and 2 of the Ipswich Rivers Flood Studies.

7.7 Design Hydrologic Modelling

Wivenhoe and Somerset Dams were included in the Brisbane River RAFTS model and a range of durations were run using the adopted losses presented in the previous section. A check was conducted to ensure that the inclusion of Wivenhoe and Somerset Dams did not effect the critical duration of the Brisbane River.

A summary for the critical duration storms and peak discharges for each catchment are presented in the following tables:

- Table 7.15: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Brisbane River, Bremer River & Warrill Creek Catchments.
- Table 7.16: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Purga Creek, Deebing Creek & Ironpot Creek Catchments.
- Table 7.17: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Mihi Creek, Sandy Creek (Chuwar) & Bundamba Creek Catchments.
- Table 7.18: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Six Mile Creek, Goodna Creek, Woogaroo Creek & Sandy Creek (Camira) Catchments.

The critical duration was determined by the peak discharge at the catchment outlet for each catchment excluding the Brisbane River, Sandy Creek (Camira) and Warrill Creek. The critical durations for the Brisbane River, Sandy Creek (Camira) and Warrill Creek were taken at Moggill Gauge, the Logan Motorway and Amberley gauges respectively. Checks were undertaken in the longer creeks to ensure that the critical duration and peak discharges did not vary throughout the reach of each river/creek. RAFTS nodes where critical durations have been taken are presented in **Table 7.15** to **Table 7.18**. Note that to avoid confusion, MIKE11 chainages have not been included as discharges presented in these tables were taken directly from the RAFTS model and will vary when compared to discharges presented in **Table G2**.

Table 7.15: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Brisbane River, Bremer River & Warrill Creek Catchments

ARI	Brisbane River NODE: JIN#		Bremer River NODE: 18		Warrill Creek NODE: AMB-OUT	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	168c	26491	48	14623	12	14094
100	30	8105	18	3233	18	3190
50	30	6892	18	2447	18	2376
20	30	5057	18	1738	18	1527
10	30	2093	18	1350	18	1010
5	30	1094	18	729	18	533
2	30	498	18	317	18	215

Table 7.16: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Purga Creek, Deebing Creek & Ironpot Creek Catchments

ARI	Purga Creek NODE: 6F		Deebing Creek NODE: DB-OUT		Ironpot Creek NODE: IP-OUT	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	5	6537	6	1210	3	810
100	4.5	1268	4.5	201	3	181
50	4.6	1021	4.5	163	3	149
20	4.5	740	4.5	123	3	114
10	4.5	572	4.5	98	3	92
5	4.6	454	4.5	79	3	74
2	4.5	277	4.6	50	3	48

Table 7.17: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Mihi Creek, Sandy Creek (Chuwar) & Bundamba Creek Catchments

ARI Years	Mihi Creek NODE: MH-OUT		Sandy Creek (Chuwar) NODE: SC-OUT		Bundamba Creek NODE: BUND 15	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	2	552	2	698	5	2698
100	1.5	103	2	146	4.5	461
50	1.5	82	2	116	4.5	376
20	2	61	2	84	4.5	278
10	2	48	3	65	6	221
5	2	39	3	52	6	180
2	2	24	3	32	6	112

Table 7.18: Existing Conditions Critical Durations and Peak Discharges for Varying ARI – Six Mile Creek, Goodna Creek, Woogaroo Creek & Sandy Creek (Camira) Catchments

ARI Years	Six Mile Creek NODE: JIIIAO		Goodna Creek NODE: JIII CG		Woogaroo Creek NODE: JIII 3M		Sandy Ck (Camira) NODE: JIII 6J	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	4	1496	5	746	4	2946	2.5	705
100	2	304	3	144	3	531	1.5	159
50	3	250	3	119	3	434	1.5	130
20	3	195	3	93	4.6	328	2	97
10	3	157	3	75	4.5	261	3	78
5	3	128	3	62	4.5	214	3	63
2	3	84	3	41	4.5	138	2	41

From **Table 7.15** it can be seen that the critical duration storm for the PMP was found to be 168 hours for the Brisbane River Catchment. The critical storm duration for the PMP event had only 9% percent variation in peak discharges predicted for the range of longer durations from 72 hours to 168 hours. As there was a significant difference between the critical durations found for the 100 year ARI and PMP events, a number of checks were conducted to ensure basic data had been interpreted and applied correctly.

The average intensities for each PMP duration were examined to ensure that the average rainfall intensity decreased as the storm duration increased.

The maximum rainfall intensity within each duration was checked to make sure that the temporal pattern was reasonably uniform without any uncharacteristic high intensities contained throughout the duration of the rainfall event.

A final check of sensitivity of time increment within the duration was conducted. This made little difference to the peak discharges and therefore it was considered that the effects of time increment were negligible.

The RAFTS model output for these events showed that the larger volumes of water associated with longer duration events caused peak discharges to occur over a longer period of time which resulted in the coincidence of peak discharges at major confluences. Conversely, the coincident peak effects for the shorter duration events were not as pronounced hence resulting in smaller peak discharges for the shorter duration storms.

Previous investigations conducted by the Department of Natural Resources found that the critical duration storm for the PMP was 120 hours and the critical duration storm for the 100 year ARI event was 24 hours. As the DNR found that there was significant differences in duration between the two recurrence intervals, it was considered that this was inherent of the catchment configuration and the rainfall variability in the catchment and the 168 hour event was adopted as the critical duration storm for the PMP event for this study.

The 200 year and 500 year ARI flood events were calculated by using peak discharges from the PMP, 100 year and 50 year ARI events using the methodology set down in Australian Rainfall and Runoff (AR&R). This method eliminated the problems associated with varying duration events. The intermediate events were calculated using this method for each catchment. The following figures illustrate the peak discharges with respect to recurrence interval.

- **Figure 7.8: Existing Conditions Design Peak Discharges for the Brisbane River – RAFTS Node JIN#**
- **Figure 7.9: Existing Conditions Design Peak Discharges for the Bremer River – RAFTS Node 1B**

- Figure 7.10: Existing Conditions Design Peak Discharges for Warrill Creek– RAFTS Node AMB-OUT
- Figure 7.11: Existing Conditions Design Peak Discharges for Purga Creek – RAFTS Node 6F
- Figure 7.12: Existing Conditions Design Peak Discharges for Deebing Creek – RAFTS Node DB-OUT
- Figure 7.13: Existing Conditions Design Peak Discharges for Ironpot Creek – RAFTS Node IP-OUT
- Figure 7.14: Existing Conditions Design Peak Discharges for Mihi Creek – RAFTS Node MH-OUT
- Figure 7.15: Existing Conditions Design Peak Discharges for Sandy Creek (Chuwar) – RAFTS Node SC-OUT
- Figure 7.16: Existing Conditions Design Peak Discharges for Bundamba Creek – RAFTS Node BUND15
- Figure 7.17: Existing Conditions Design Peak Discharges for Six Mile Creek – RAFTS Node JINAO
- Figure 7.18: Existing Conditions Design Peak Discharges for Goodna Creek – RAFTS Node JINCG
- Figure 7.19: Existing Conditions Design Peak Discharges for Woogaroo Creek – RAFTS Node JIN3M
- Figure 7.20: Existing Conditions Design Peak Discharges for Sandy Creek (Camira) – RAFTS Node JIN6J

It should be noted that the stage-storage and stage-discharge curves within RAFTS were extended to account for the larger design flood events. The extension of these curves was done assuming vertical banks and hence the only additional storage was confined to within the creek proper. The stage discharge curves were extended linearly following the general trend of the calibrated curves. These assumptions were considered to be a conservative estimate however given the available information (ie cross sectional and topographical) these assumptions were considered to be appropriate.

The return period for the PMP flood event varied for each of the catchments. These return periods were determined using Table 13.1 of AR&R.

Figure 7.8: Existing Conditions Design Peak Discharges for the Brisbane River – RAFTS Node JIN#

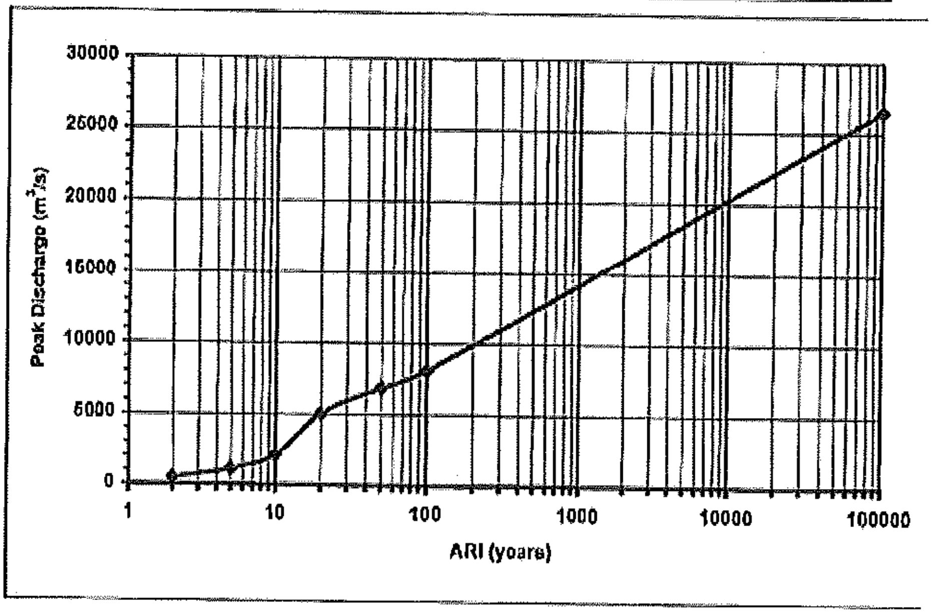


Figure 7.9: Existing Conditions Design Peak Discharges for the Bremer River – RAFTS Node 1B

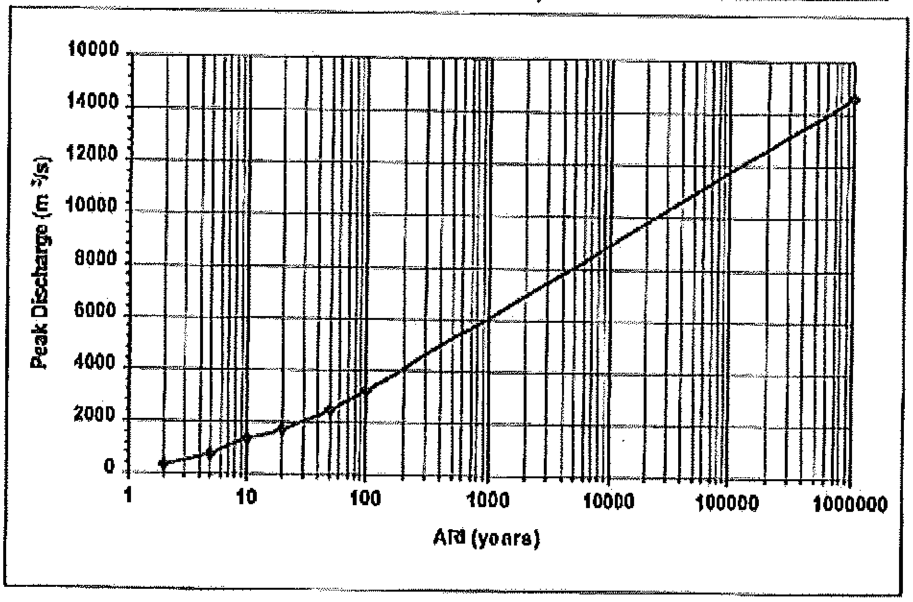


Figure 7.10: Existing Conditions Design Peak Discharges for Warrill Creek– RAFTS Node AMB-OUT

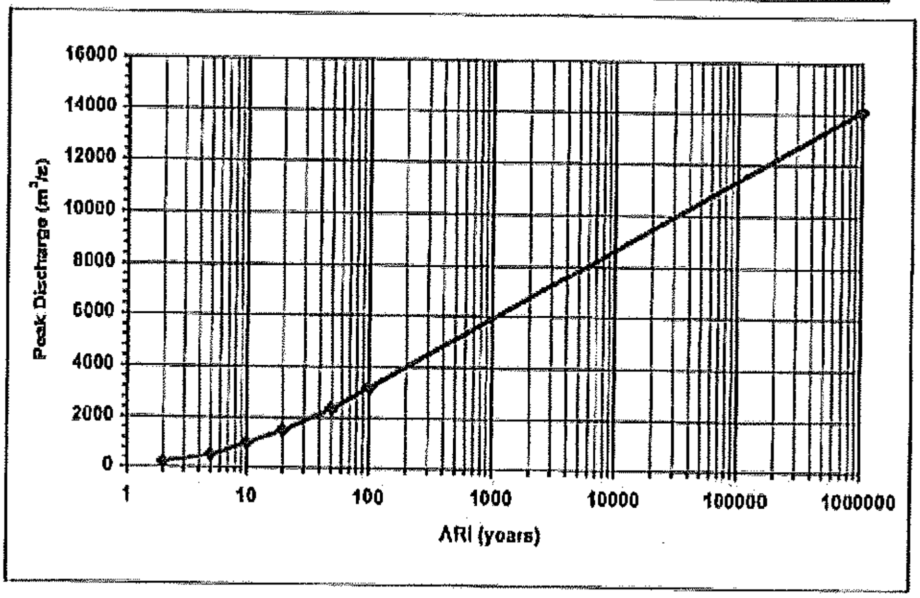


Figure 7.11: Existing Conditions Design Peak Discharges for Purga Creek – RAFTS Node 6F

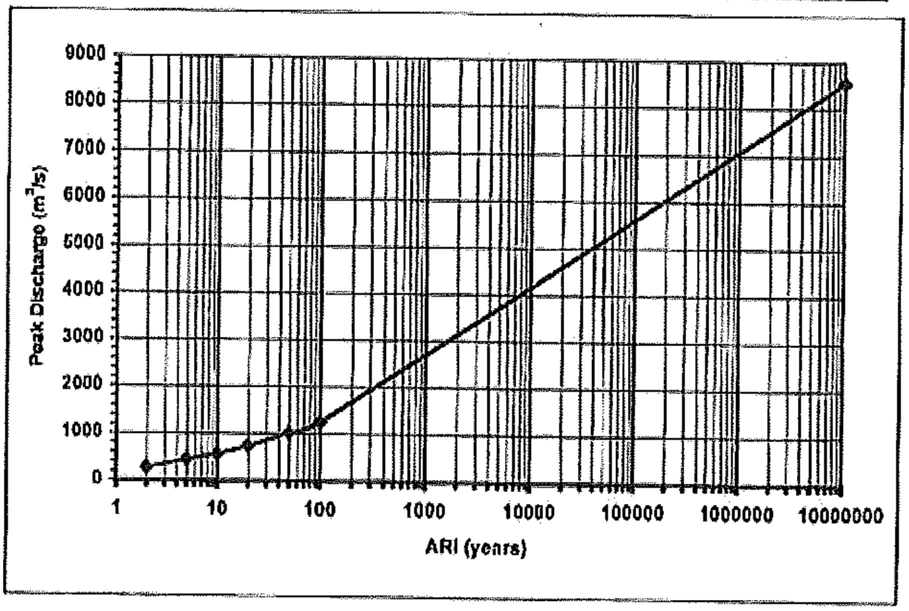


Figure 7.12: Existing Conditions Design Peak Discharges for Deebing Creek – RAFTS Node DB-OUT

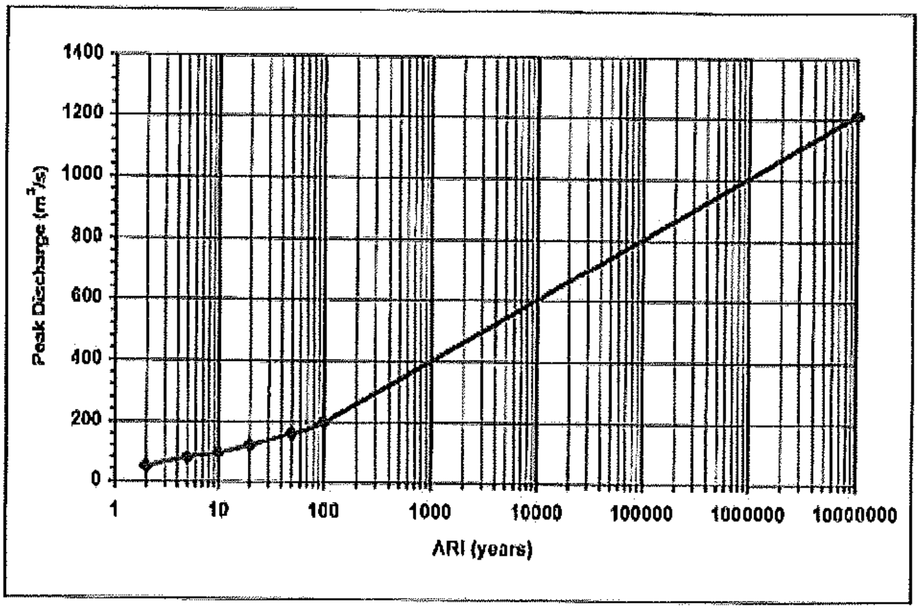


Figure 7.13: Existing Conditions Design Peak Discharges for Ironpot Creek – RAFTS Node IP-OUT

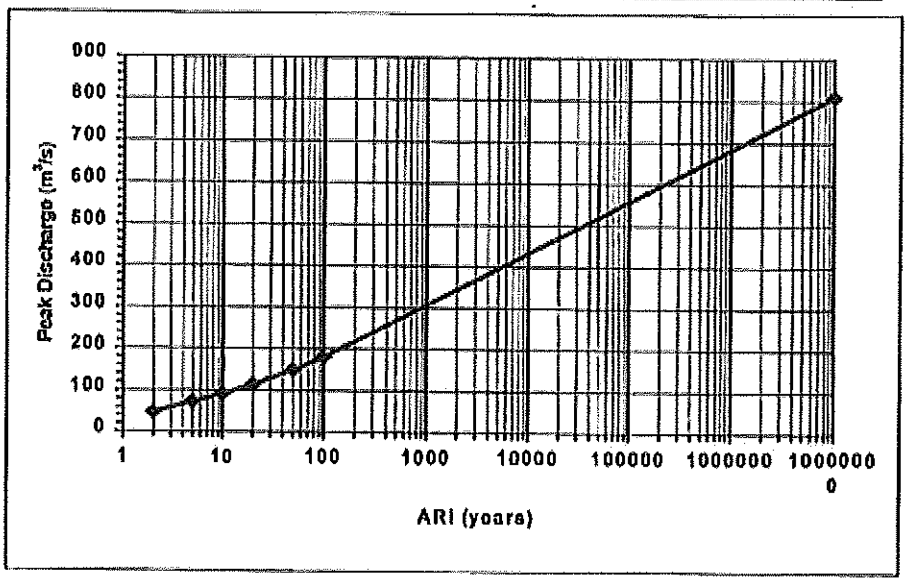


Figure 7.14: Existing Conditions Design Peak Discharges for Mihi Creek – RAFTS Node MH-OUT

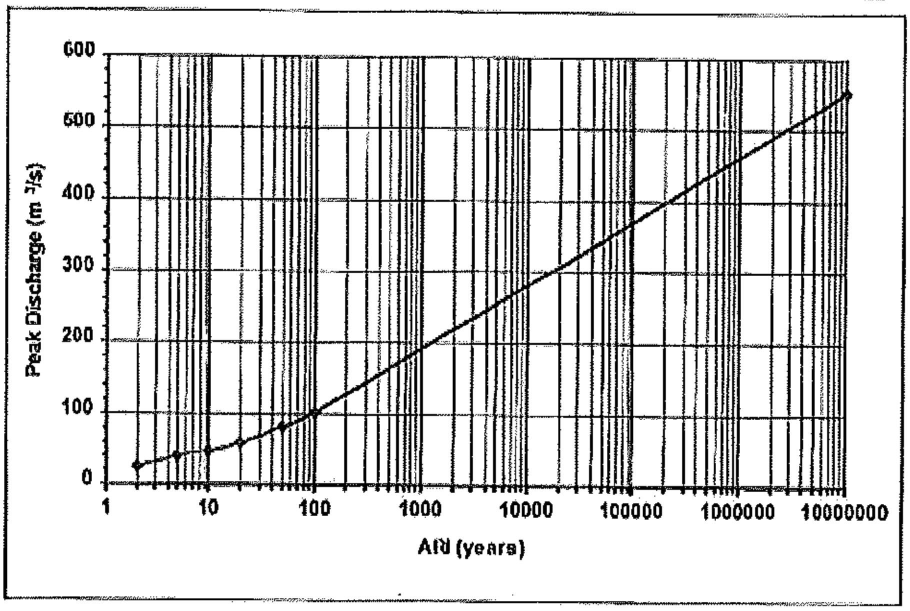


Figure 7.15: Existing Conditions Design Peak Discharges for Sandy Creek (Chuwar) – RAFTS Node SC-OUT

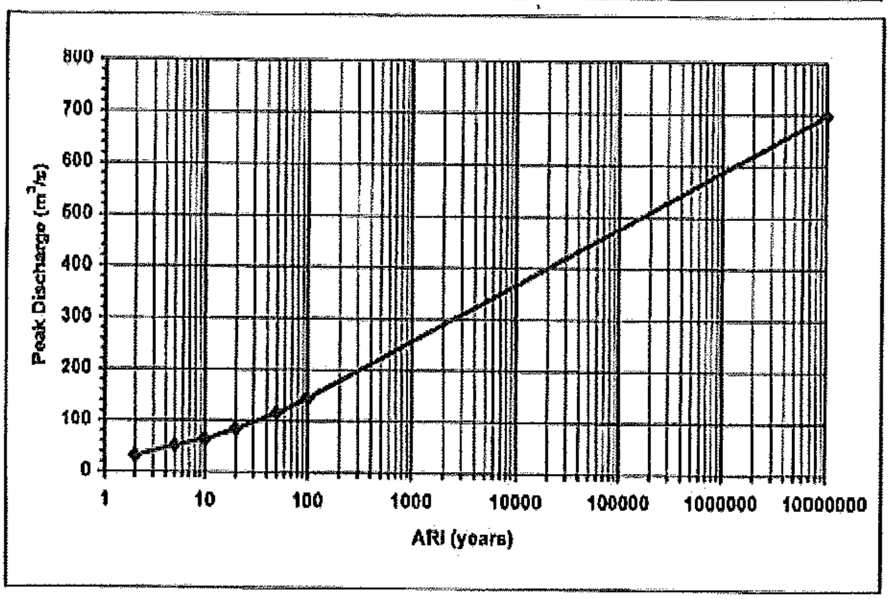


Figure 7.16: Existing Conditions Design Peak Discharges for Bundamba Creek – RAFTS Node BUND16

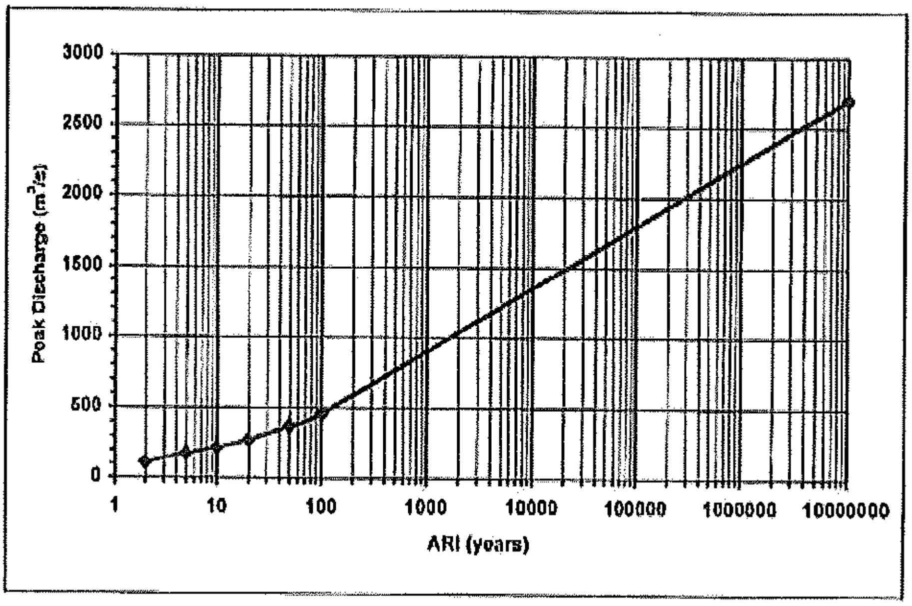


Figure 7.17: Existing Conditions Design Peak Discharges for Six Mile Creek – RAFTS Node JINAO

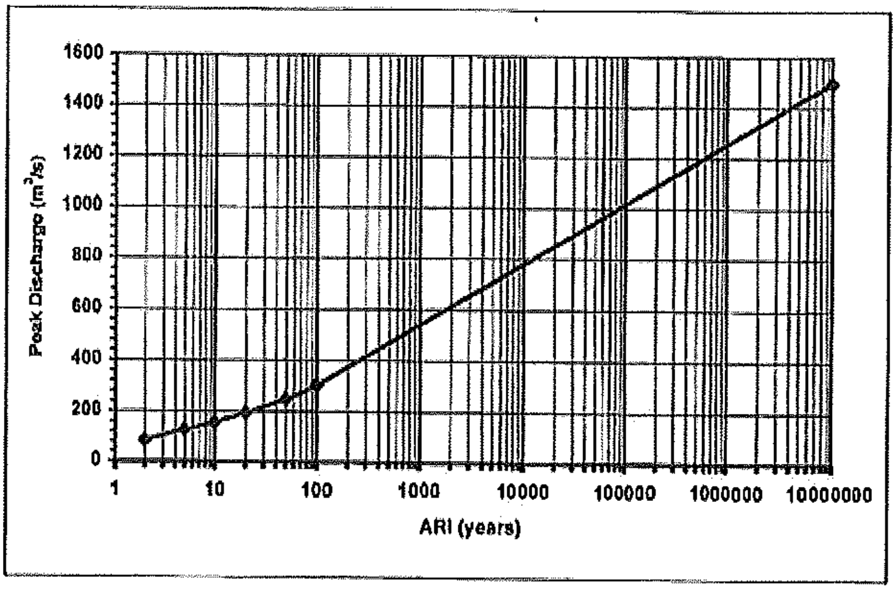


Figure 7.18: Existing Conditions Design Peak Discharges for Goodna Creek – RAFTS Node JINCG

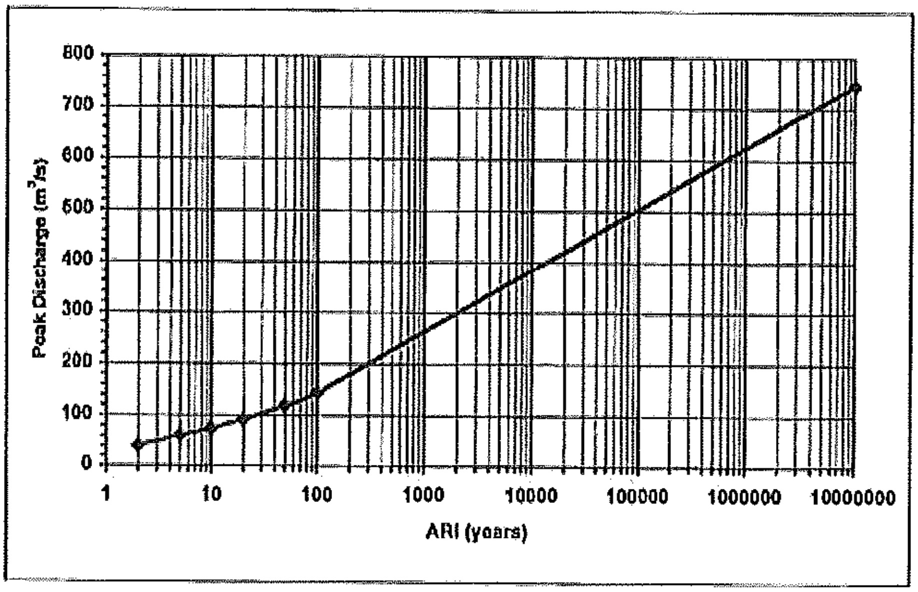


Figure 7.19: Existing Conditions Design Peak Discharges for Woogaroo Creek – RAFTS Node JIN3M

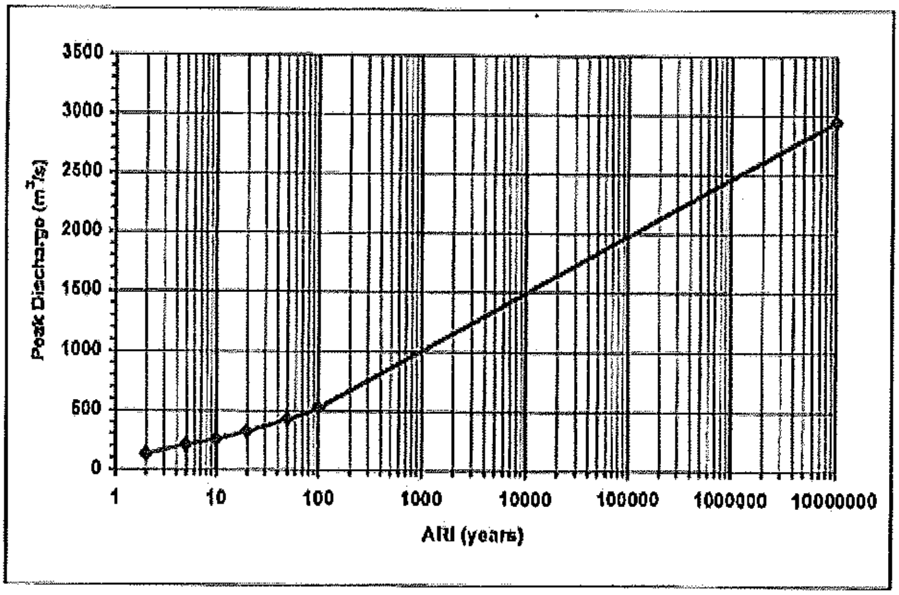
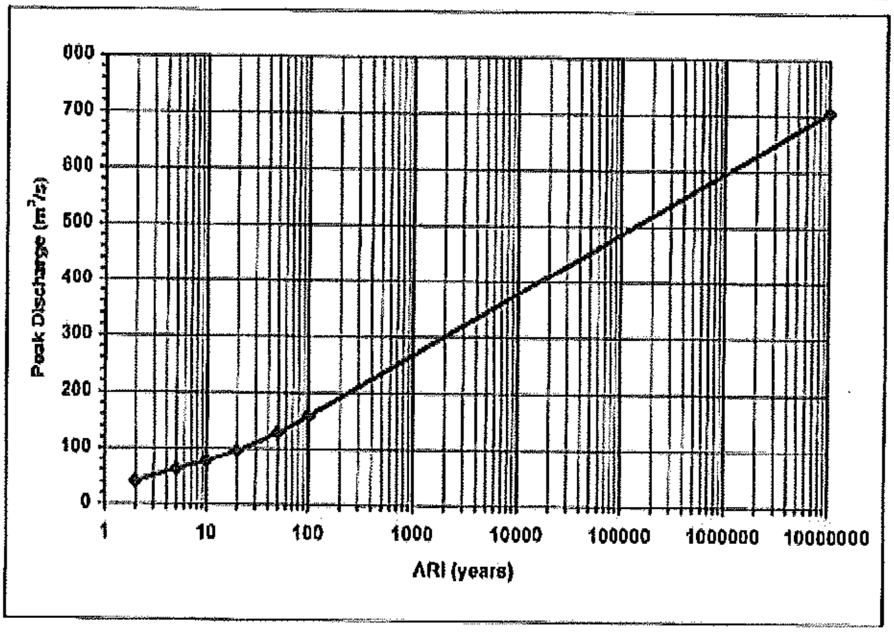


Figure 7.20: Existing Conditions Design Peak Discharges for Sandy Creek (Camira) – RAFTS Node JIN6J



Once the peak discharges for these events were calculated, an average ratio was determined and the PMP rainfall depths were scaled and applied to the catchment. The temporal pattern corresponding to the critical duration for the PMP for each catchment was adopted and the scaled intermediate storms were run through RAFTS. These scaling factors were adjusted for the 500 and 200 year ARI flood levels until a good match between the AR&R peak calculated discharges and the peak RAFTS discharges was achieved. **Table 7.19: Existing Conditions Peak Predicted Discharges for the 500 and 200 Year ARI Events for Each River/Creek** present the outcomes of this analysis.

Table 7.19: Existing Conditions Peak Predicted Discharges for the 500 and 200 Year ARI Events for Each River/Creek

Location	500 Year ARI			200 Year ARI		
	Calc (m^3/s)	RAFTS (m^3/s)	% error	Calc (m^3/s)	RAFTS (m^3/s)	% error
Brisbane Riv	10675	10650	-0.2	9212	9172	-0.4
Bremer Riv	4825	4831	+0.1	3910	3930	+0.3
Warrill Ck	4714	4716	+0.1	3847	3841	-0.1
Purga Ck	2282	2290	+0.3	1704	1700	-0.3
Deebing Ck	342	343	+0.2	262	261	-0.1
Ironpot Ck	269	269	0.0	219	218	-0.4
Mihi Ck	166	166	0.0	130	130	0.0
Sandy Ck (Chuwar)	223	223	0.0	179	179	0.0
Bundamba Ck	773	776	+0.3	596	593	-0.4
Six Mile Ck	470	471	+0.1	376	375	-0.1
Goodna Ck	228	228	0.0	180	180	0.0
Woogaroo Ck	868	869	0.0	676	673	-0.5
Sandy Ck (Camira)	235	234	-0.5	192	191	-0.3

Table 7.19 shows that the calculated discharges are within 0.5% of the RAFTS predicted discharges and hence considered acceptable.

7.8 Hydrologic and Hydraulic Model Consistency

A consistency check between the hydrologic and hydraulic models was conducted during the calibration phase of the study to ensure that predicted peak discharges and time to peaks were within a specified tolerance of 10%. Generally a good match was achieved however the calibration events were rainfall events with a duration of between 3 and 7 days. Since the longest duration event for the design phase of the study was predicted to be 30 hours (100 year ARI Brisbane River Flood), it was therefore considered necessary to check that the consistency between the long duration events and the shorter duration design events (ie. up to 30 hours) was still acceptable.

The RAFTS hydrologic model was run and the discharge hydrographs were input into the MIKE11 hydraulic model. A consistency check was performed and it was found that there was poor consistency between the two models.

As MIKE11 contains actual cross-section information, the storage in this model is an accurate representation of the actual storage and hence the conceptual storages in RAFTS had to be adjusted until the peak discharges produced by RAFTS matched those predicted by the MIKE11 model.

This was not of a major concern as the conceptual storages in RAFTS do not effect the results produced in MIKE11 as local inflow hydrographs produced by RAFTS are used as inputs into the MIKE11 model.

The adjustments were made and a good consistency was achieved. These adjustments to the conceptual storages in RAFTS will not have any impact on the calibration of the RAFTS or MIKE11 models.

7.9 Discussion

The hydrological model performance during the analysis of the design events was considered to be generally good. Comparison between peak discharge estimates from the flood frequency analysis and the RAFTS model showed good agreement between the different methods. This identified that the RAFTS model was reliably estimating design discharges.

Loss parameters adopted for the assessment were considered to be within the bounds of acceptable limits.

The performance of the dam operations were simplified, however, the predicted dam releases agree reasonably well with recent flood operations.

8. Design Event Hydraulics

8.1 Tailwater Boundary Conditions

A tailwater boundary condition for design model runs was at the Western Inner Bar. This tidal condition was:

- Mean High Water Spring Tide (RL 0.92 m AHD).

This level was used at the downstream end of the Brisbane River as a boundary condition for the MIKE11 hydraulic model.

It was recognised that varying conditions at the mouth of the Brisbane River (Western Inner Bar) may be caused by storm surges in Moreton Bay. These conditions are likely to impact on flood profiles within the lower reaches of the Brisbane River and may have some impact on Brisbane River tributaries. The storm surge condition analysed in this study was:

- 100 year ARI river flood coinciding with a 100 year ARI Moreton Bay storm surge.

Peak storm surge levels for the Western Inner Bar (post Wivenhoe Dam) were supplied by Brisbane City Council and are presented in **Table 8.1: Western Inner Bar Flood Levels.**

Table 8.1: Western Inner Bar Flood Levels

Design ARI (years)	Storm Surge Level (m AHD)	Storm Surge Level + Greenhouse Effect Levels (m AHD)
100	2.14	2.50

Brisbane City Council requires that an allowance of 300 mm be added to storm surge levels to account for Greenhouse effects. Once this level was determined it was rounded up to the nearest 0.1 m as required. Design modelling for this study used the adjusted Greenhouse effect tailwater levels presented in **Table 8.1**. The storm surge level used in this study at the Western Inner Bar was assumed to be RL 2.5 m AHD. This level is consistent with the level used in the Brisbane River Flood Study.

Although a 100 year ARI Moreton Bay storm surge occurring concurrently with a 100 year ARI Brisbane River flood will have a probability of less than a 1 in 100 years flood event, it was considered appropriate to show what impacts tailwater levels at the Western Inner Bar could have on the Lower Brisbane River and its tributaries. This flooding scenario was only investigated for the Brisbane River 30 hour storm.

Flood level profiles are presented in the **Ipswich Rivers Flood Study Atlas – MIKE11 Design Profiles Existing Conditions Sheets 65 to 67.**

Table G-1 – Predicted Flood Levels and Comparison presents the flood levels for the 100 year ARI Moreton Bay Storm surge with a 100 year ARI Brisbane River Flood.

Table 8.2: Increases in Flood Levels between 100 Year ARI Brisbane River Flood with MHWS Tailwater Level and 100 Year ARI Brisbane River Flood with 100 Year ARI Moreton Bay Storm Surge – Existing Conditions, presents the maximum increase in flood levels in each of the river/creeks within the boundaries of Ipswich City.

Table 8.2: Increases in Flood Levels between 100 Year ARI Brisbane River Flood with MHWS Tailwater Level and 100 Year ARI Brisbane River Flood with 100 Year ARI Moreton Bay Storm Surge – Existing Conditions

River/Creek	Maximum Increase Due to Storm Surge (mm)
Brisbane	80
Bremer	60
Six Mile	60
Goodna	70
Sandy (Camira)	0
Woogaroo	80
Warrill	0
Purga	0
Bundamba	60
Deebing	10
Ironpot	10
Mihi	20
Sandy (Chuwar)	60

From Table 8.2 it can be seen that the maximum increase in flood level due to a 100 year ARI Moreton Bay Storm Surge with a 100 year ARI Brisbane River Flood is 80 mm.

8.2 Hydraulic Model Parameters

All hydraulic structures were included in the design events assessment.

Mannings 'n' values derived in the calibration phase of the study for the January 1974 flood event were adopted as the design events parameters. These parameters were adopted primarily on the basis that the Trust would be more interested in the larger flood events as these events produce flood levels that are most likely to be adopted for development levels.

The adoption of the January 1974 Mannings 'n' values may overestimate flood levels for the more frequent flood events.

8.3 Design Flood Profiles

The inflow hydrographs calculated by the RAFTS model for the full range of design storms were run through the MIKE11 model for the current extent of urbanisation to generate a series of design flood profiles.

Flooding in the study area, especially of the Bremer River and its tributaries, may be caused by a range of storm scenarios. These scenarios generate different flooding responses as described below:

- Local Tributary Storm - A localised, relatively short duration storm may result in high peak discharges into downstream waterways. This may produce fast flow velocities (potentially causing erosion) and high flood levels in the upper reaches.

- Bremer River Storm - A more widespread, longer duration storm may result in high discharges at the lower end of Bremer River causing backwater effects in local tributaries.

- Brisbane River Storm - A regional storm may produce high peak discharges in the Brisbane River at the junction of Bremer River, causing low velocity backwater effects. This storm will have a significantly longer duration (about 30 hours) compared to the local tributary storm (of the order of 2 to 6 hours).

These processes have been taken into account during the determination of design flood profiles. **Figure 8.1: Design Profile Example** shows how the critical storms (ie storm duration that generates the peak discharge) for the Local, Bremer River and Brisbane River may produce a series of flood profiles. The 'envelope' of the maximum flood levels along the length of the waterway provides a basis for flood inundation mapping. As shown, it is anticipated that the Local Storm will generate the highest flood levels in the extreme upper reaches and the Brisbane River Storm will lead to flood level maxima within the lower reaches.

Figure 8.1: Design Profile Example

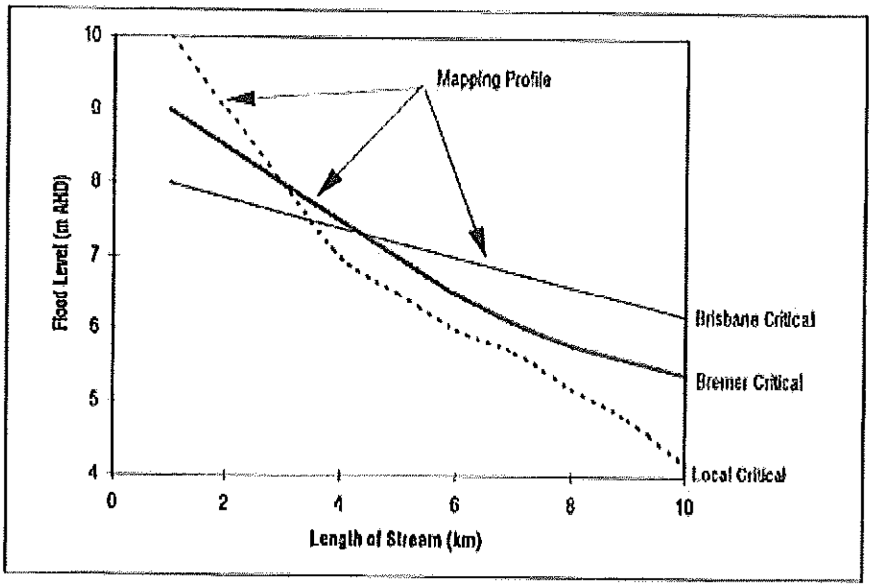


Table 8.3 - Design Storm Scenarios provides a summary of the combinations of design storms that have been assessed for design flood estimation. Note that the Bremer River and Tributaries Flood Study applies to all three scenarios, the Brisbane River Flood Study applies to the Brisbane River Storm only and the Brisbane River Tributaries Flood Study will apply the Local and Brisbane River Storms.

Table 8.3 - Design Storm Scenarios

Storm Scenario	Storm to be Applied		
	Local Catchment	Bremer Catchment	Brisbane Catchment
Local	Local Critical	No Storm	No Storm
Bremer	Bremer Critical	Bremer Critical	Bremer Critical
Brisbane	Brisbane Critical	Brisbane Critical	Brisbane Critical

Note - 1. Local Critical is the storm duration that generates the highest peak discharge at the outlet of the Local catchment
2. Bremer Critical is the storm duration that generates the highest peak discharge at the outlet of the Bremer River
3. Brisbane Critical is the storm duration that generates the highest peak discharge in the Brisbane River at the Bremer River junction.

The flood profiles for the each river/creek have been plotted for the range of return periods and are presented in the **Ipswich Rivers Flood Study Atlas Sheets 55 to 67**;

Design flood discharges and peak water levels are presented in **Table G-1: Design Events Predicted Flood Levels** and **Table G-2: Design Events Predicted Discharges**. It has been assumed that the handrails at all structures would be fully blocked by debris during the design events.

8.4 Discussion

The MIKE11 hydraulic model generally predicted that Brisbane River Flooding predominantly influenced flooding in both the Brisbane River and the Bremer River tributaries.

Flooding in the upper reaches of the tributaries was generally found to be due to local catchment flooding effects.

For a section of the Bremer River shown on **Sheet 68** of the atlas a pronounced saw tooth effect is evident for the PMF flood profile between Chainages 1004590 and 1008390.

This effect is primarily due to the hydraulic model being set up to best represent the 100 year ARI flood event. The saw tooth effect is caused by truncated cross sections. At these truncated cross sections, the PMF is well above the maximum cross section level and extents. Where this occurs, the velocity through the truncated cross sections increases significantly and causes a decrease in flood levels. There is no easy solution to this problem except generate a separate hydraulic model for large and extreme events. Large and extreme event flood levels determined in this study were only derived to give indicative estimates of flood levels for emergency procedures and as such the profiles presented are considered appropriate.

A similar effect occurs for this reach under Ultimate Catchment Conditions (refer **Atlas Sheet 71**).

9. Ultimate Catchment Hydrology

The future urbanisation of areas in Ipswich and Brisbane may cause the peak runoff to increase and occur earlier during the flood event. Generally the upper areas of the creeks and rivers in this study are predominantly rural and the extent of future urbanisation in these areas will be negligible. Urbanisation effects in these rural areas have therefore not been investigated.

9.1 Impervious Area

The future urbanisation for Ipswich City was determined from the current Ipswich City Council Strategic Plan which was broken down into the following five land uses:

- Urban (assumed to be 50% impervious)
- Rural (assumed to be 0% impervious)
- Industrial (assumed to be 90% impervious)
- Special Use (assumed to be 30% impervious)
- Non Committed (assumed to be 50% impervious).

The percent impervious values above were derived using estimates provided in the Queensland Urban Drainage Manual (Qudm). Non Committed areas were assigned the value of 50% impervious which was based on the assumption that these areas would be residential areas in the future.

The total impervious area for each sub-catchment was derived using the following formula:

Total Impervious Area = 0.5.Urban Area + 0.9. Industrial Area + 0.3.Special Use Area + 0.5.Non Committed Area.

A comparison between the existing conditions case and ultimate conditions case pervious and impervious areas are presented in **Appendix H: Pervious and Impervious Areas.**

9.2 Ultimate Conditions Hydrologic Modelling

The existing conditions case RAFTS hydrological model was modified to reflect future urbanisation. The RAFTS model was rerun for a range of durations at each ARI to determine the critical duration for each ARI.

The same loss rates determined in the design events phase of the study were used for the ultimate catchment analysis. A summary of these loss rates are presented in **Table 7.14: Summary of Adopted Loss Parameters - Ipswich Rivers Flood Studies.**

Wivenhoe and Somerset Dams were included in the ultimate catchments modelling. The initial conditions and dam operations used for the design events phase of the studies was also used to model the ultimate catchment.

A summary of the critical duration storms and peak discharges for each catchment are presented in the following tables.

- **Table 9.1: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Brisbane River, Bremer River & Warrill Creek Catchments .**
- **Table 9.3: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Mihi Creek, Sandy Creek (Chuwar) & Bundamba Creek Catchments .**
- **Table 9.4: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Six Mile Creek, Goodna Creek, Woogaroo Creek & Sandy Creek (Camira) Catchments .**

The critical duration was determined by the peak discharge at the catchment outlet for each catchment excluding the Brisbane River, Sandy Creek (Camira) and Warrill Creek. The critical durations for the Brisbane River, Sandy Creek (Camira) and Warrill Creek were taken at Moggill Gauge, the Logan Motorway and Amberley gauges respectively. Checks were undertaken in the longer creeks to ensure that the critical duration and peak discharges did not vary throughout the reach of each river/creek.

RAFTS nodes where critical durations have been taken are presented in **Table 9.1** to **Table 9.4**. Note that to avoid confusion, MIKE11 chainages have not been included as discharges presented in these tables were taken directly from the RAFTS model and will vary when compared to discharges presented in **Table G2**.

Table 9.1: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Brisbane River, Bremer River & Warrill Creek Catchments

ARI	Brisbane River NODE: JIH#		Bremer River NODE: 1B		Warrill Creek NODE: AMB-OUT	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	168	26461	48	14583	12	14092
100	30	8095	18	3140	18	3100
50	30	6882	18	2358	18	2299
20	30	5047	18	1604	18	1434
10	30	2072	18	1259	18	899
5	30	1083	18	719	18	474
2	30	493	18	306	18	216

Table 9.2: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Purga Creek, Deebing Creek & Ironpot Creek Catchments

ARI	Purga Creek NODE: 6F		Deebing Creek NODE: DB-OUT		Ironpot Creek NODE: IP-OUT	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	5	8498	5	1210	4	962
100	4.5	1265	4.5	248	2	184
50	4.5	1021	4.5	207	2	150
20	4.5	740	4.5	162	3	117
10	4.5	572	4.5	132	3	95
5	4.5	454	4.5	109	3	78
2	4.5	277	4.5	72	3	52

Table 9.3: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Mihi Creek, Sandy Creek (Chuwar) & Bundamba Creek Catchments

ARI Years	Mihi Creek NODE: MH-OUT		Sandy Creek (Chuwar) NODE: SC-OUT		Bundamba Creek NODE: BUND15	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	2	575	2	698	5	2420
100	1	111	2	148	12	438
50	1	89	2	116	12	354
20	2	67	3	84	3	267
10	2	53	3	65	3	210
5	2	44	3	52	3	181
2	2	29	3	32	3	122

Table 9.4: Ultimate Conditions Critical Durations and Peak Discharges for Varying ARI – Six Mile Creek, Goodna Creek, Woogaroo Creek & Sandy Creek (Camira) Catchments

ARI Years	Six Mile Creek NODE: JIMAD		Goodna Creek NODE: JIHCG		Woogaroo Creek NODE: JIN 3M		Sandy Ck (Camira) NODE: JIN6J	
	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)	Crit Duration (hrs)	Peak Q (m^3/s)
PMP	3	1526	4	827	4	2873	2.5	644
100	2	325	3	173	3	514	1.5	155
50	3	269	3	144	3	420	1.5	127
20	3	209	3	113	3	321	1.5	96
10	3	170	3	92	3	256	1.5	77
5	3	141	3	76	6	206	1.5	64
2	3	93	3	50	6	135	3	42

The 200 year and 500 year ARI flood events were calculated by using peak discharges from the PMP, 100 year and 50 year ARI events using the methodology set down in Australian Rainfall and Runoff (AR&R). This method eliminated the problems associated with varying duration events. The intermediate events were calculated using this method for each catchment. The following figures illustrate the peak discharges with respect to recurrence interval.

- **Figure 9.1: Ultimate Conditions Peak Discharges for the Brisbane River – RAFTS Node JIN#**
- **Figure 9.2: Ultimate Conditions Peak Discharges for the Bremer River – RAFTS Node 1B**
- **Figure 9.3: Ultimate Conditions Peak Discharges for Warrill Creek – RAFTS Node AMB-OUT**
- **Figure 9.4: Ultimate Conditions Peak Discharges for Purga Creek – RAFTS Node 6FFigure 9.5: Ultimate Conditions Peak Discharges for Deebing Creek – RAFTS Node DB-OUT**
- **Figure 9.6: Ultimate Conditions Peak Discharges for Ironpot Creek – RAFTS Node IP-OUT**
- **Figure 9.7: Ultimate Conditions Peak Discharges for Mihi Creek – RAFTS Node MH-OUT**
- **Figure 9.8: Ultimate Conditions Peak Discharges for Sandy Creek (Chuwar) – RAFTS Node SC-OUT**
- **Figure 9.9: Ultimate Conditions Peak Discharges for Bundamba Creek – RAFTS Node BUND15**Figure 9.10: Ultimate Conditions Peak Discharges for Six Mile Creek – RAFTS Node JINAO
- **Figure 9.11: Ultimate Conditions Peak Discharges for Goodna Creek – RAFTS Node JINCG**
- **Figure 9.12: Ultimate Conditions Peak Discharges for Woogaroo Creek – RAFTS Node JIN3M**
- **Figure 9.13: Ultimate Conditions Peak Discharges for Sandy Creek (Camira) – RAFTS Node JIN6J**

It should be noted that the stage-storage and stage-discharge curves within RAFTS were extended to account for the larger design flood events. The extension of these curves was done assuming vertical banks and hence the only additional storage was confined to within the creek proper. The stage discharge curves were extended linearly following the general trend of the calibrated curves. These assumptions were considered to be a conservative estimate however given the available information (ie cross sectional and topographical) these assumptions were considered to be appropriate.

The return period for the PMP flood event varied for each of the catchments. These return periods were determined using Table 13.1 of AR&R.

Figure 9.1: Ultimate Conditions Peak Discharges for the Brisbane River – RAFTS Node JIN#

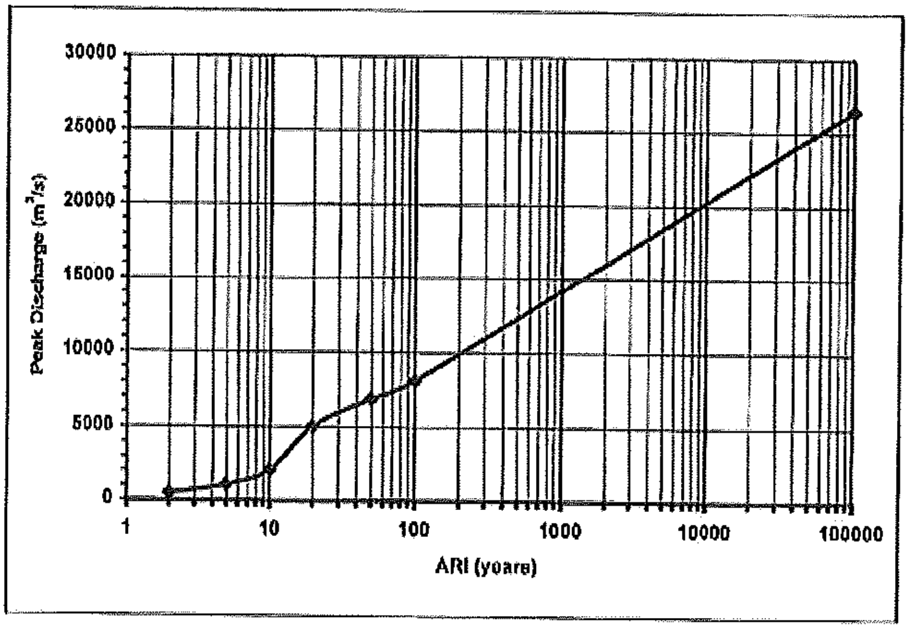


Figure 9.2: Ultimate Conditions Peak Discharges for the Bremer River – RAFTS Node 1B

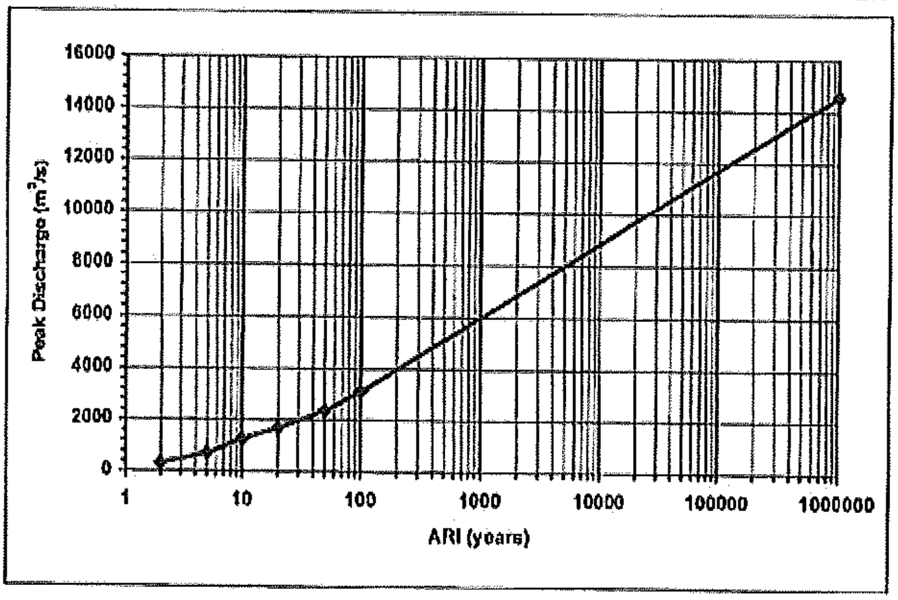


Figure 9.3: Ultimate Conditions Peak Discharges for Warrill Creek – RAFTS Node AMB-OUT

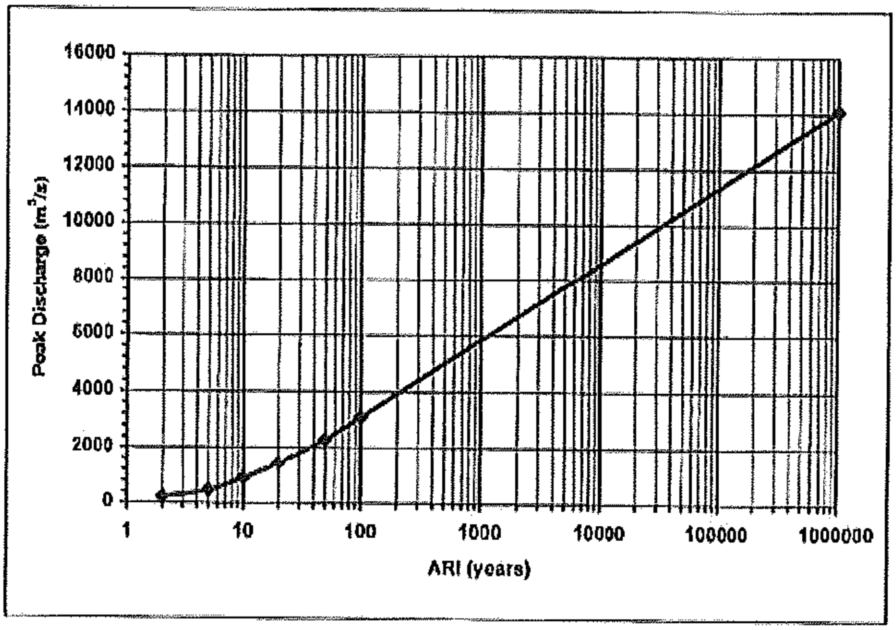


Figure 9.4: Ultimate Conditions Peak Discharges for Purga Creek – RAFTS Node 6F

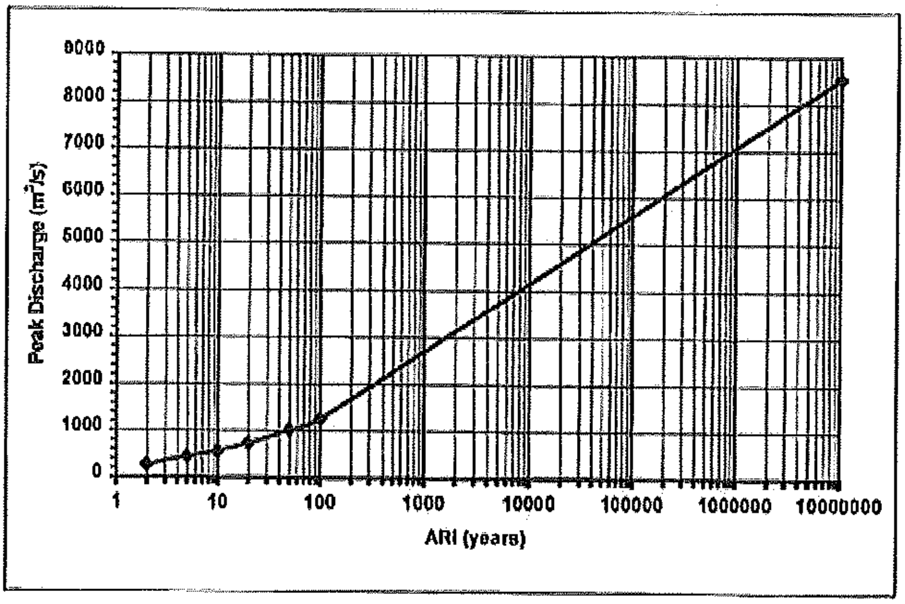


Figure 9.5: Ultimate Conditions Peak Discharges for Deebing Creek – RAFTS Node DB-OUT

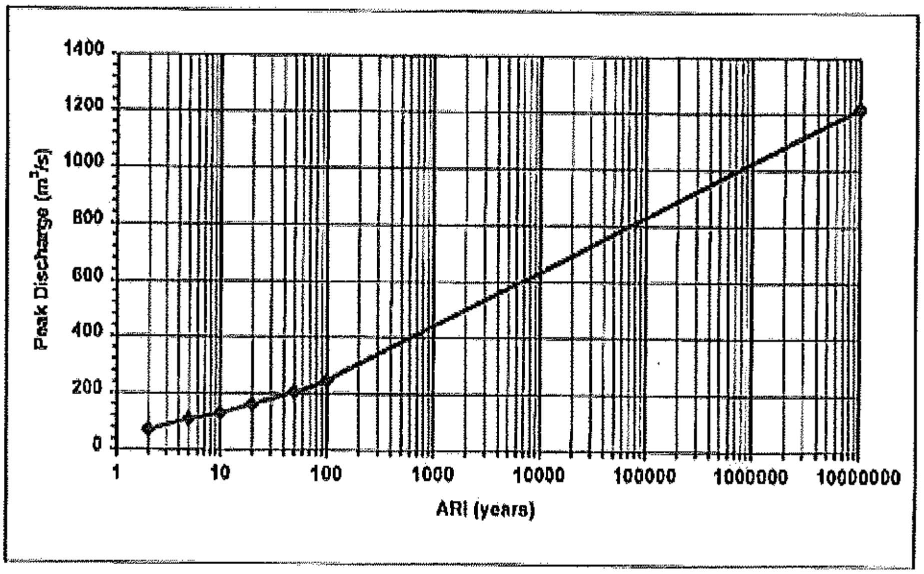


Figure 9.6: Ultimate Conditions Peak Discharges for Ironpot Creek – RAFTS Node IP-OUT

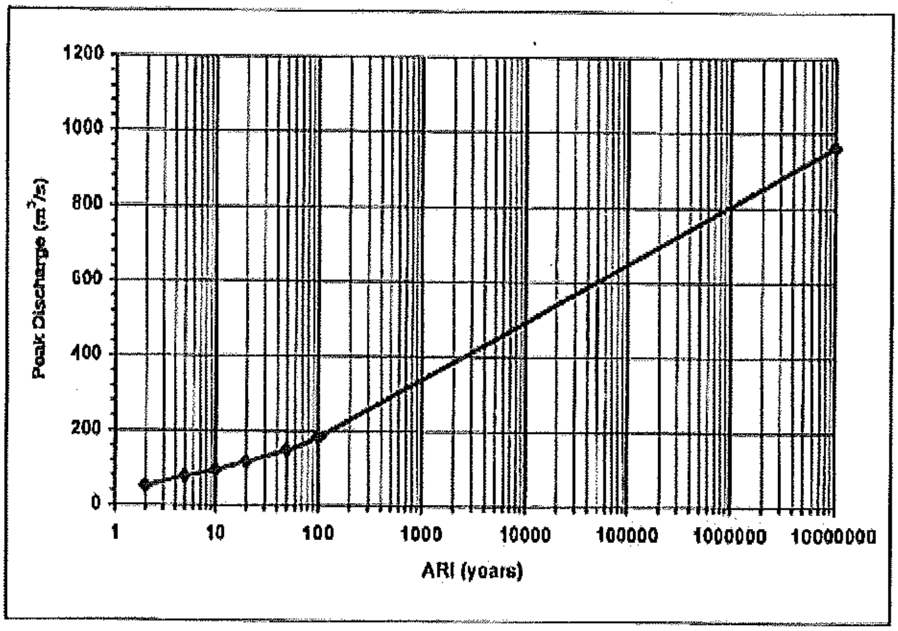


Figure 9.7: Ultimate Conditions Peak Discharges for Mihi Creek – RAFTS Node MH-OUT

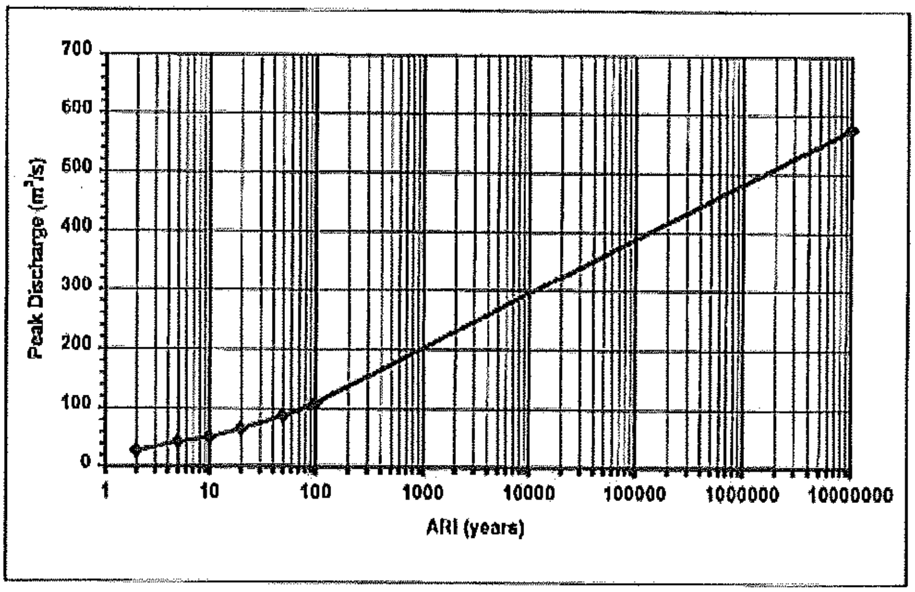


Figure 9.8: Ultimate Conditions Peak Discharges for Sandy Creek (Chuwar) – RAFTS Node SC-OUT

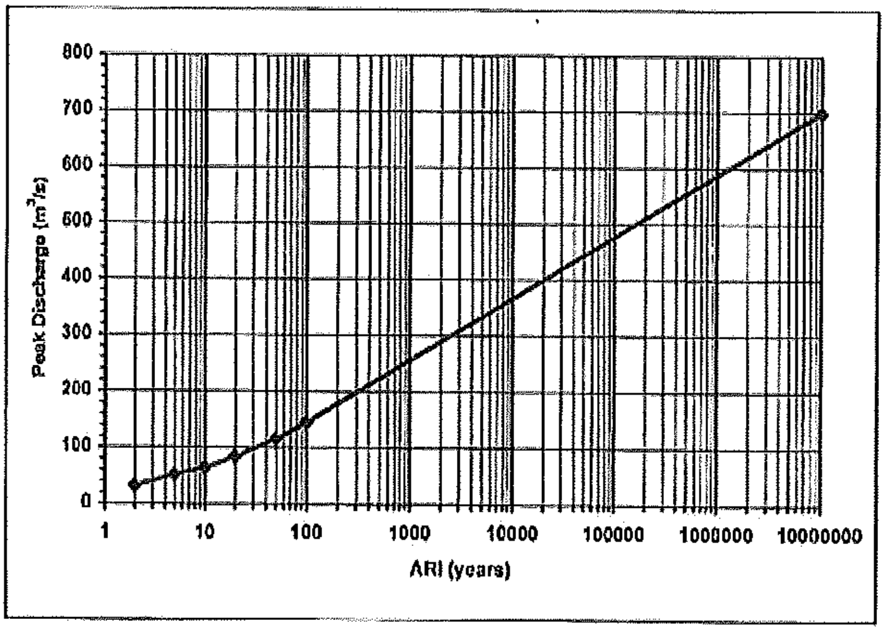


Figure 9.9: Ultimate Conditions Peak Discharges for Bundamba Creek – RAFTS Node BUND15

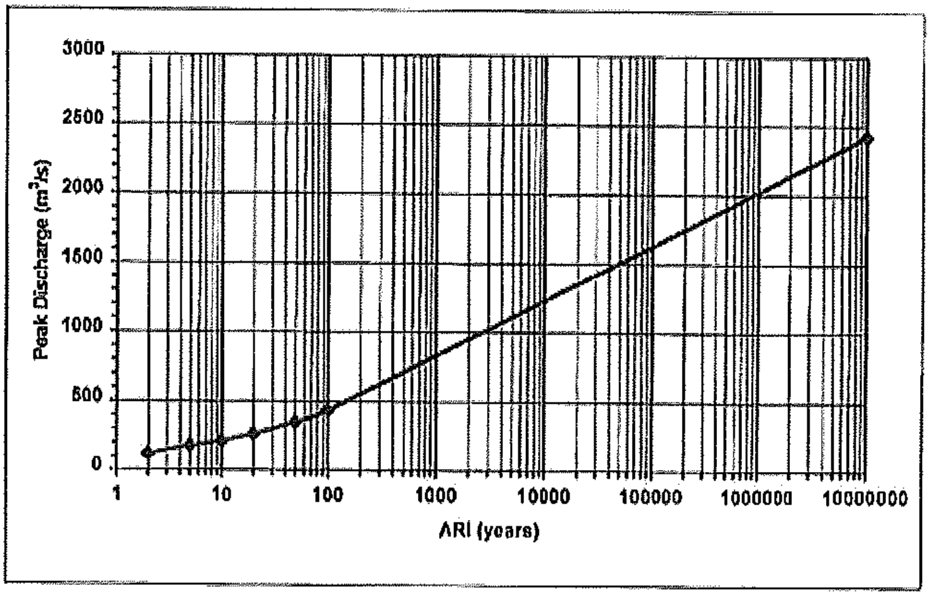


Figure 9.10: Ultimate Conditions Peak Discharges for Six Mile Creek – RAFTS Node JINAO

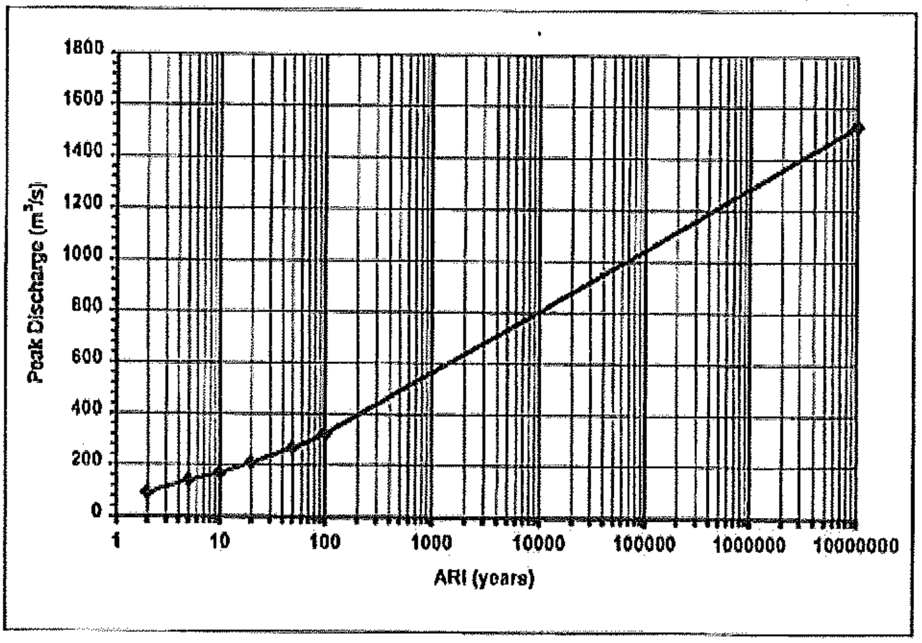


Figure 9.11: Ultimate Conditions Peak Discharges for Goodna Creek – RAFTS Node JINCG

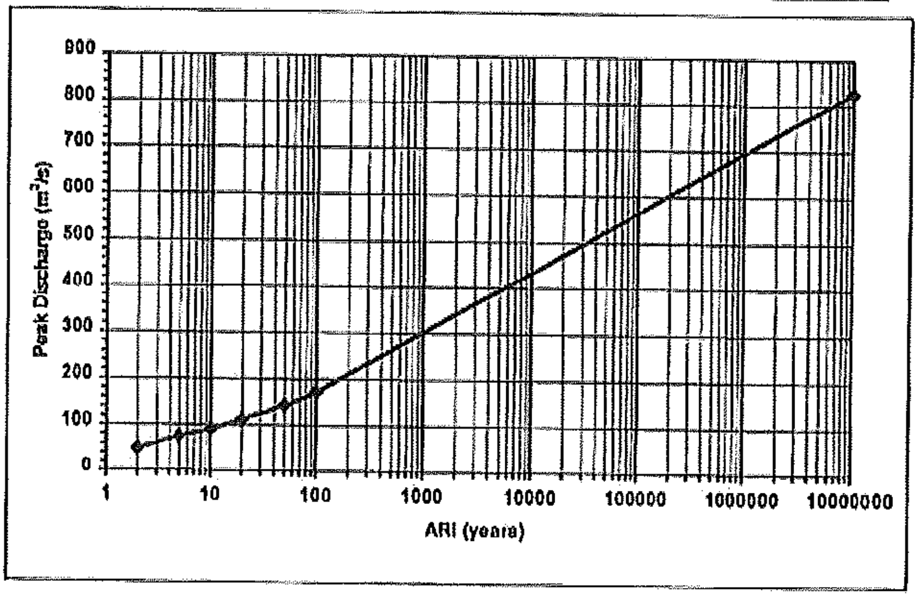


Figure 9.12: Ultimate Conditions Peak Discharges for Woogaroo Creek – RAFTS Node JIN3M

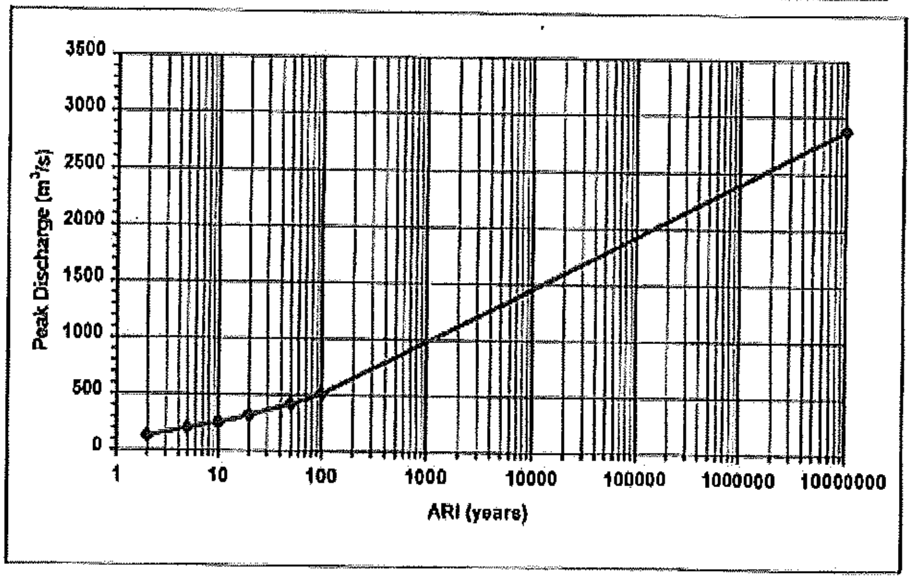
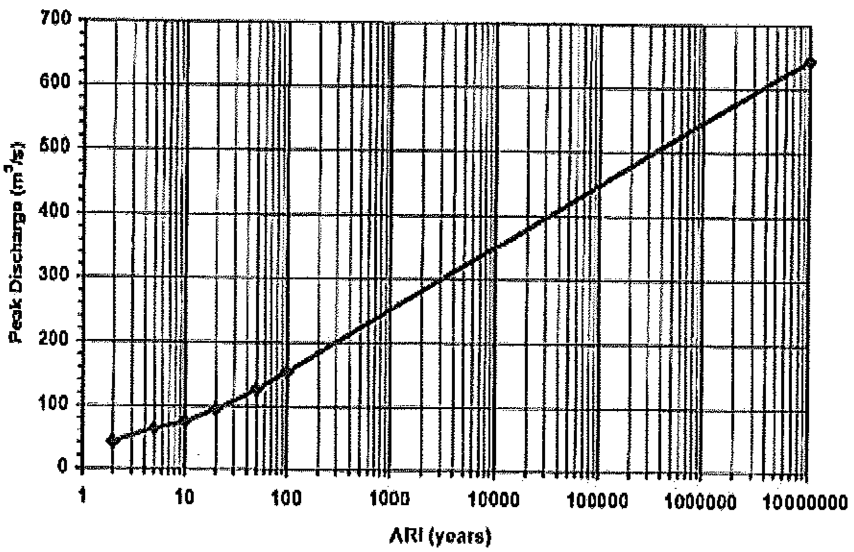


Figure 9.13: Ultimate Conditions Peak Discharges for Sandy Creek (Camira) – RAFTS Node JIN6J



Once the peak discharges for the intermediate events were calculated, the PMP rainfall depths were scaled and applied to the catchment. The temporal pattern corresponding to the critical duration for the PMP for each catchment was adopted and the scaled intermediate storms were run through RAFTS. These scaling factors were adjusted for the 500 and 200 year ARI flood levels until a good match between the AR&R peak calculated discharges and the peak RAFTS discharges was achieved. **Table 9.5: Ultimate Conditions Peak Predicted Discharges for the 500 and 200 Year ARI Events for Each River/Creek** present the outcomes of this analysis.

Table 9.5: Ultimate Conditions Peak Predicted Discharges for the 500 and 200 Year ARI Events for Each River/Creek

Location	500 Year ARI			200 Year ARI		
	Calc (m^3/s)	RAFTS (m^3/s)	% error	Calc (m^3/s)	RAFTS (m^3/s)	% error
Brisbane Riv	10662	10620	-0.3	9201	9224	+0.3
Bremer Riv	4740	4756	+0.4	3829	3827	0.0
Warrill Ck	4637	4630	-0.1	3762	3774	+0.3
Purga Ck	2276	2279	+0.1	1701	1700	0.0
Deebing Ck	384	385	+0.2	306	307	+0.1
Ironpot Ck	293	293	0.0	231	231	0.0
Mihi Ck	176	176	0.0	139	139	0.0
Sandy Ck (Chuwar)	223	223	0.0	179	179	0.0
Bundamba Ck	715	715	0.0	557	560	+0.4
Six Mile Ck	493	492	-0.2	397	398	+0.1
Goodna Ck	264	263	-0.3	211	211	0.0
Woogaroo Ck	844	843	-0.1	656	654	-0.3
Sandy Ck (Camira)	223	223	0.0	184	184	0.0

Table 9.5 shows that the calculated discharges are within 0.4% of the RAFTS predicted discharges and hence considered acceptable.

9.3 Existing and Ultimate Discharge Comparison

A comparison between the peak discharges for the Existing Case and the Ultimate Catchment Conditions Case was conducted for the 100 year and 20 year ARI flood events. **Table 9.6: Existing and Ultimate Conditions Case Discharge Comparison for the 100 Year and 20 Year ARI Flood Events** presents the results of the comparison.

The results presented in **Table 9.6** can be divided into the following:

- The ultimate catchments discharges for Deebing Creek, Ironpot Creek, Mihi Creek, Six Mile Creek and Goodna Creek are greater than the existing case peak predicted flood discharges. This is due to the increase in impervious areas caused by urbanisation and the location of the future urbanisation in the catchment.

- Purga Creek, and Sandy Creek (Chuwar) have no change in the predicted peak discharges No future ubanisation has been proposed in Sandy Creek (Chuwar) and the proposed urbanisation in Purga Creek was at the lower end of the catchment and was considered to be small.

- The ultimate catchment predicted peak discharges for the Brisbane River, Bremer River, Warrill Creek, Bundamba Creek, Woogaroo Creek and Sandy Creek (Camira) are less than the discharge predicted for the existing case catchment. This reduction occurs because each of these rivers/creeks have long main streams with the majority of the future urbanisation at the lower end of the catchments. In this situation, the time of concentration of the lower catchment reduces due to the urbanisation effects. This allows runoff from the lower catchment to disperse prior to the runoff from the upper catchments reaching the lower catchments hence reducing peak flows.

Table 9.6: Existing and Ultimate Conditions Case Discharge Comparison for the 100 Year and 20 Year ARI Flood Events

River/Creek	100 Year ARI			20 Year ARI		
	Existing Q (m^3/s)	Ultimate Q (m^3/s)	Difference (m^3/s)	Existing Q (m^3/s)	Ultimate Q (m^3/s)	Difference (m^3/s)
Brisbane	8105	8095	-0.1	5057	5047	-0.2
Bremer	3233	3140	-2.9	1738	1684	-3.1
Warrill	3190	3100	-2.8	1527	1434	-6.1
Purga	1266	1266	0.0	740	740	0.0
Deebing	201	248	+23.4	123	162	+33.3
Ironpot	181	184	+1.7	114	117	+2.6
Mihi	103	111	+7.8	61	67	+9.8
Sandy (Chuwar)	146	146	0.0	84	84	0.0
Bundamba	461	438	-5.0	278	267	-4.0
Six Mile	304	325	+6.9	195	209	+7.2
Goodna	144	173	+20.1	93	113	+21.5
Woogaroo	531	514	-3.0	326	321	-1.6
Sandy (Camira)	159	155	-2.5	97	96	-1.0

Note: Discharges presented are at the river/creek outlet

From Table 9.6 the maximum change in discharge due to urbanisation ranges from -6% to +33%.

10. Ultimate Catchment Hydraulics

10.1 Boundary Conditions

A tailwater boundary condition for ultimate case model runs at the Western Inner Bar is consistent with the tailwater level used in the design events phase of the study. This tidal condition was:

- Mean High Water Spring Tide (RL 0.92 m AHD).

This level was used at the downstream end of the Brisbane River as a boundary condition for the MIKE11 hydraulic model.

The inflow hydrographs predicted by the ultimate case RAFTS hydrological model were input into the MIKE11 model.

10.2 Hydraulic Model Parameters

All hydraulic structures were included in the ultimate case events assessment.

Similarly to the design events assessment, Mannings 'n' values derived in the calibration phase of the study for the January 1974 flood event were adopted as the ultimate case events parameters. These parameters were adopted primarily on the basis that the Trust would be more interested in the larger flood events as these events produce flood levels that are most likely to be adopted for development levels.

The adoption of the January 1974 Mannings 'n' values may overestimate flood levels for the more frequent flood events.

10.3 Existing and Ultimate Catchments Comparison

A full listing of predicted peak flood levels, discharges and velocities for the varying ARI are presented in the following tables in Appendix G.

- **Table G-1: Predicted Peak Flood Levels and Comparison**
- **Table G-2: Predicted Peak Discharges and Comparison**
- **Table G-3: Predicted Peak Velocities and Comparison – 100 & 20 Year ARI Events.**

A summary of the predicted peak flood levels for the 100 year and 20 year ARI flood events at key locations is presented in

Table 10.1: Comparison of Predicted Peak Flood Levels for the 100 Year ARI & 20 Year ARI Flood Events at Key Locations.

Table 10.1: Comparison of Predicted Peak Flood Levels for the 100 Year ARI & 20 Year ARI Flood Events at Key Locations

River/Creek	Location	MIKE11 Chainage (km)	100 Year ARI			20 Year ARI		
			Existing WL (m AHD)	Ultimate WL (m AHD)	Difference (mm)	Existing WL (m AHD)	Ultimate WL (m AHD)	Difference (mm)
Brisbane	U/S Boundary	BNE 964.17	38.03	38.03	0	33.07	33.07	0
Brisbane	Kholo Bdg	BNE 979.51	31.42	31.42	0	26.31	26.31	0
Brisbane	Mt Crosby Weir	BNE 988.17	27.08	27.06	-20	22.05	22.05	0
Brisbane	Colleges Xing	BNE 992.48	25.28	25.27	-10	20.28	20.27	-10
Brisbane	Moggill Gauge	BNE1006.30	18.34	18.27	-70	13.55	13.53	-20
Brisbane	D/S Boundary	BNE 1014.61	16.80	16.71	-90	12.08	12.07	-10
Bremer	U/S Boundary	BREM 1000.00	27.18	27.05	-140	23.83	23.70	-130
Bremer	One Mile Bdg	BREM 1004.60	24.47	24.34	-130	20.74	20.59	-150
Bremer	Wulkaraka Bdg	BREM 1006.50	23.32	23.18	-140	19.65	19.50	-150
Bremer	Hancock Bdg	BREM 1008.40	21.94	21.80	-140	18.31	18.17	-140
Bremer	Railway Workshops Bdg	BREM 1011.80	18.73	18.55	-180	15.21	15.05	-160
Bremer	David Trumpy Bdg	BREM 1012.06	18.65	18.48	-170	15.11	14.98	-150
Bremer	Warrego Hway Bdg	BREM 1023.50	18.38	18.31	-70	13.59	13.57	-20
Warrill	Cunningham Hway	WAR 100.00	28.23	28.14	-90	26.50	26.43	-70
Purga	Cunningham Hway	PUR 100.00	27.24	27.12	-120	24.77	24.77	0.00
Deebing	Cunningham Hway	DEEB 12.04	28.47	28.57	+10	28.05	28.14	+90
Deebing	Ash St Bdg	DEEB 13.91	26.33	26.45	+110	25.61	25.71	+100
Deebing	Warwick Rd Bdg	DEEB 17.07	24.63	24.50	-130	20.85	20.70	-150
Ironpot	Warrego Hway	IRON 12.64	33.49	33.60	+110	33.01	33.01	0
Ironpot	Sydney St Bdg	IRON 18.38	22.25	22.11	-140	18.69	18.56	-140
Ironpot	Wairuna Ct Bdg	IRON_BR1 1.87	53.17	53.26	+90	53.07	53.07	0
Mihi	Ips-Warrego Connect	MIHI 10.73	20.51	20.82	+310	19.80	19.82	+20
Mihi	Hunter St	MIHI 11.30	20.39	20.23	-160	16.90	16.76	-140
Mihi	Warrego Hway	MIHI_BR1 1.38	35.60	35.50	-40	35.23	35.27	+50
Mihi	Pine Mountain Rd	MIHI_BR1 2.58	20.39	20.23	-160	16.90	16.77	-130
Sandy (Chuwar)	Robin St	SCH 10.60	18.71	18.71	0	18.50	18.50	0
Sandy (Chuwar)	Warrego Hway	SCH 11.91	18.38	18.31	-70	13.93	13.80	-70
Sandy (Chuwar)	Mt Crosby Rd	SCH 12.45	18.38	18.31	-70	13.93	13.86	-70
Bundamba	Ripley Rd Bdg	BUND 16.74	48.30	48.00	-350	47.90	47.81	-90
Bundamba	Swanbank Rd Bdg	BUND 25.59	31.73	31.54	-190	31.29	31.16	-140
Bundamba	Patrick St Bdg	BUND 27.39	28.41	28.24	-160	27.90	27.75	-150
Bundamba	Cunningham Hway	BUND 28.51	26.58	26.37	-210	25.99	25.84	-150
Bundamba	Blackstone Rd Bdg	BUND 31.99	21.42	21.28	-130	20.68	20.46	-220
Bundamba	Blackstone Rail Bdg	BUND 32.36	20.90	20.73	-160	19.97	19.76	-210
Bundamba	Brisbane Rd Bdg	BUND 34.33	18.38	18.31	-70	16.91	16.68	-260
Bundamba	Basketball Rail Bdg	BUND 35.11	18.38	18.31	-70	14.55	14.45	-110
Bundamba	Bris-Ips Rail Bdg	BUND 35.53	18.38	18.31	-70	13.96	13.89	-70
Bundamba	Gledson St Bdg	BUND 36.02	18.38	18.31	-70	13.96	13.89	-70

Six Mile	Hallets Rd xing	SIX 10.37	38.95	30.05	0	38.58	38.581	0
Six Mile	Redbank Plains Rd Bdg	SIX 11.79	33.01	32.91	-10	32.67	32.78	-90
Six Mile	Ipswich Rd Bdg	SIX 19.85	17.95	17.87	-70	13.16	13.15	-10
Six Mile	Bris-Ips Rail Bdg	SIX 20.15	17.95	17.87	-70	13.16	13.15	-10
Goodna	Kruger Pde Bdg	GOOD 12.03	17.23	17.15	-80	15.41	16.59	+180
Goodna	Ipswich Rd Bdg	GOOD 14.24	17.23	17.15	-80	12.51	12.50	-10
Goodna	Bris-Ips Rail Bdg	GOOD 14.60	17.23	17.15	-80	12.51	12.50	-10
Goodna	Brisbane Tce Bdg	GOOD 14.01	17.23	17.15	-80	12.51	12.50	-10
Woogaroo	Edna St Bdg	WOOG 15.85	16.71	16.69	-20	12.04	12.03	-10
Woogaroo	Ipswich Rd Bdg	WOOG 17.34	16.71	16.69	-20	12.04	12.03	-10
Woogaroo	Bris-Ipswich Rail Bdg	WOOG 17.45	16.71	16.69	-20	12.04	12.03	-10
Woogaroo	Brisbane Tce Bdg	WOOG 17.77	16.71	16.67	-20	12.01	12.03	-10
Sandy (Camira)	Addison St Bdg	SAND 11.05	41.05	41.04	-10	40.85	40.81	-40
Sandy (Camira)	Ishmael St Bdg	SAND 11.53	38.60	38.57	-30	38.30	38.24	-60
Sandy (Camira)	Cochrane St Bdg	SAND 12.01	37.18	37.13	-60	36.56	36.42	-140
Sandy (Camira)	Logan Motorway xing	SAND 14.72	24.90	24.77	-100	24.55	24.34	-210

From **Table 10.1** it can be seen that changes in flood levels vary from –350mm to +310mm. These variations are due to the changes in discharges due to urbanisation. Note that effects of filling of the floodplain have not been investigated for these studies.

10.4 Ultimate Conditions Case Flood Profiles

The inflow hydrographs calculated by the RAFTS model for the full range of design storms were run through the MIKE11 model for the current extent of urbanisation to generate a series of design flood profiles.

Flood profiles were generated using the methodology outlined in **Section 8.3: Design Flood Profiles.**

The ultimate conditions case flood profiles for the each river/creek have been plotted for the range of return periods and are presented in the **Ipswich Rivers Flood Study Atlas MIKE11 Design Profiles Ultimate Conditions, Sheets 68 to 80.**

It has been assumed that the handrails at all structures would be fully blocked by debris during the Ultimate Catchment Events.

11. Flood Mapping & Flood Mitigation

11.1 Overview

The flood maps associated with the Ipswich Rivers Flood Studies were generated using results from the MIKE11 hydraulic model for the Ultimate Catchments Conditions cases. The Digital Elevation Model (DEM) developed for Ipswich City Council (Landinfo 1999) was used in conjunction with the MIKE 11 results to produce depth/inundation plots over the studies areas.

Flood mitigation options have been identified based on the extent of flooding for the 100 year ARI flood event primarily to protect existing infrastructure.

11.2 Flood Mapping

Results from the MIKE11 hydraulic model for the Ultimate Catchments Conditions Cases were used to create a flood water surface for the 100 year and 20 year ARI flood events. The Geographical Information System (GIS) used to generate this flood water surface was MapInfo in conjunction with Vertical Mapper.

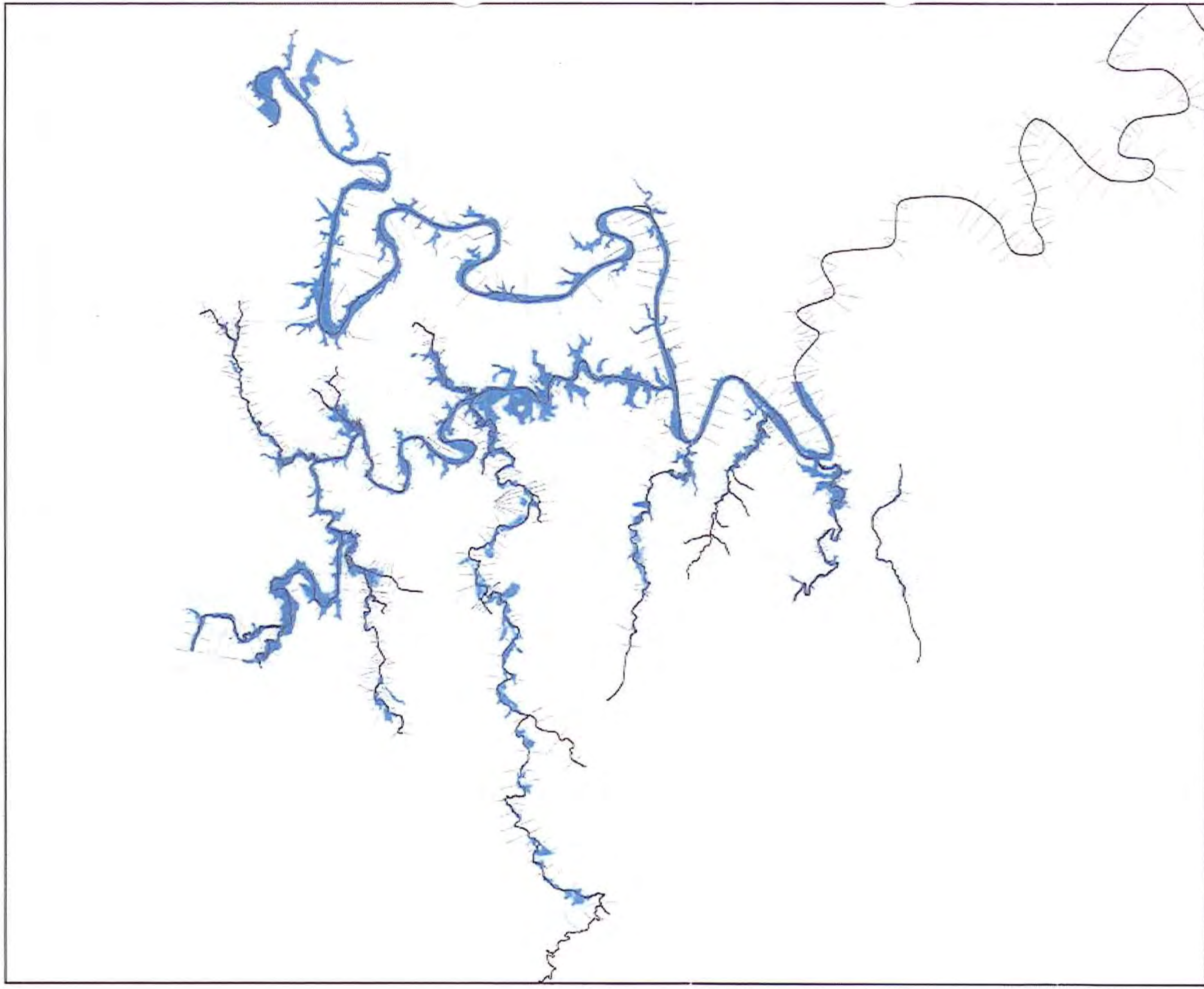
Once the flood water surfaces had been generated, the surfaces were overlayed onto the DEM of Ipswich City. This allowed depth/inundation plans to be generated for the 100 year and the 20 year ARI flood events.

An overview of the extents of inundation in the Ipswich City area can be seen on the following figures:

- **Figure 11.1: 100 Year ARI Flood Depth/Inundation Summary for Ultimate Catchment Conditions Case**
- **Figure 11.2: 20 Year ARI Flood Depth/Inundation Summary for Ultimate Catchment Conditions Case.**

These plans are also presented as **Sheets 81** and **82** in the Flood Study Atlas.

The digital files for these depth/inundation plans have been provided to the Ipswich City Council. The depth/inundation plans have been overlayed on contours and the digital cadastral database (DCDB) of the city and a series of 1 in 10 000 scale high resolution flood inundation plans have been generated. These plans are presented in the Flood Study Atlas as **Sheet 83 to 113: Flood Inundation Lines for 20 and 100 Year ARI Events Ultimate Conditions Case.**



Ipswich City Council

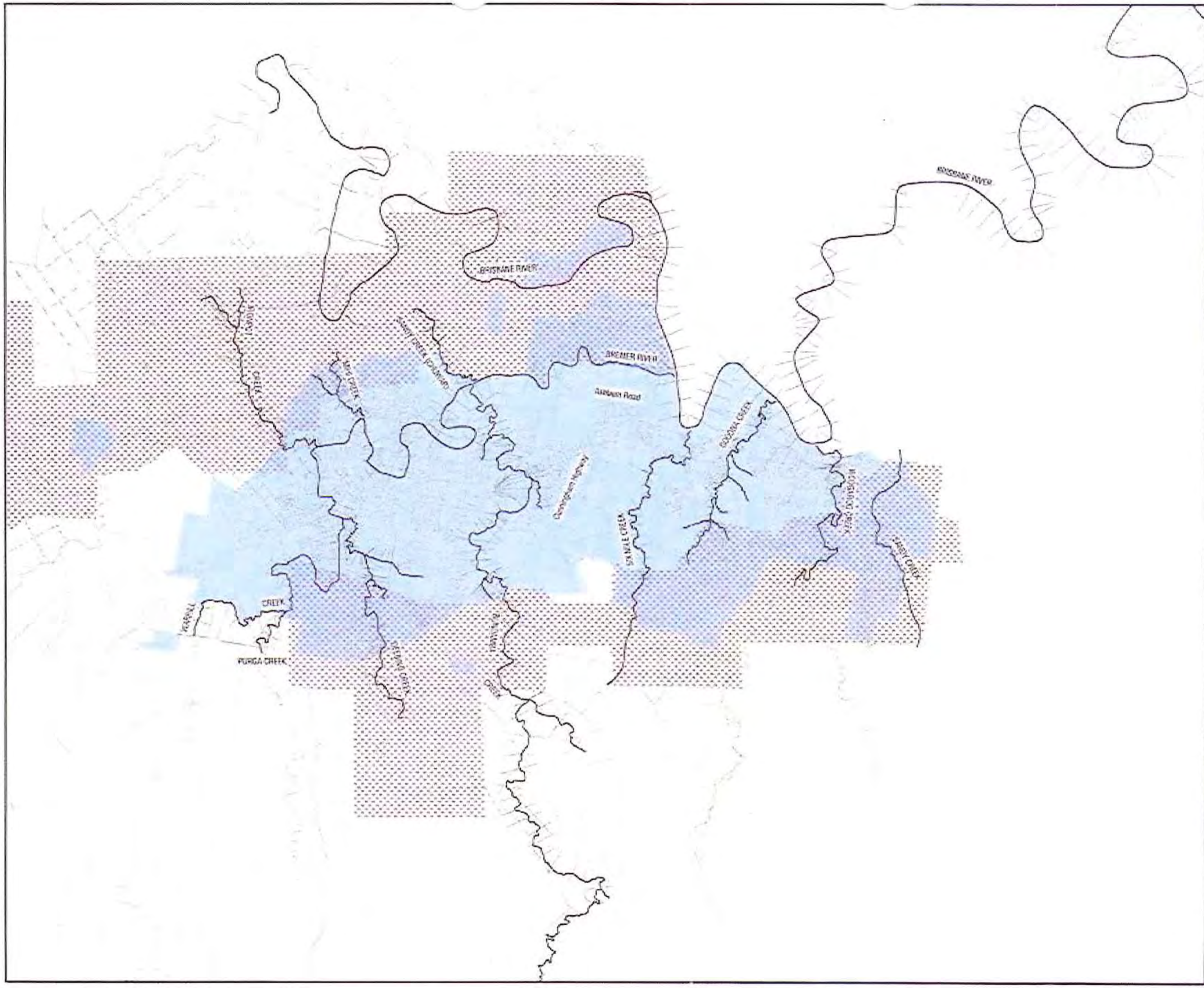
IPSWICH RIVERS FLOOD STUDY

20 YEAR ARI FLOOD DEPTH/INUNDATION SUMMARY FOR ULTIMATE CONDITIONS CASE

FIGURE 11.2

SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd for Ipswich City Council
RE04350
inundation-02(A3).wor



Ipswich City Council

IPSWICH RIVERS FLOOD STUDY

IPSWICH CITY AREA CONTOURS

FIGURE 11.3

SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd for Ipswich City Council
RE04390
Contour-01(A3)

The accuracy of flood modelling and mapping is a function of the quality of the hydrologic and hydraulic model calibration and the reliability of the topographic information used to represent the flood plain. A summary of the accuracy of the different aspects of the flood modelling and mapping is given below:

- predicted flood levels - ±0.2 m
- predicted horizontal extent of inundation – up to +10 m from the location shown
- predicted depths of inundation ±½ the topographic contour interval ±0.2 m.

The accuracy of the predicted depths of inundation will be influenced by the accuracy of the topographic contours. The contour accuracy varies across the floodplain as illustrated on **Figure 11.3: Ipswich City Area Contours** (Atlas Sheet 114). In areas of 0.5 m contours, the accuracy would range from ±0.45 m. In the areas of 5.0 m contours the accuracy would vary from ±2.7 m.

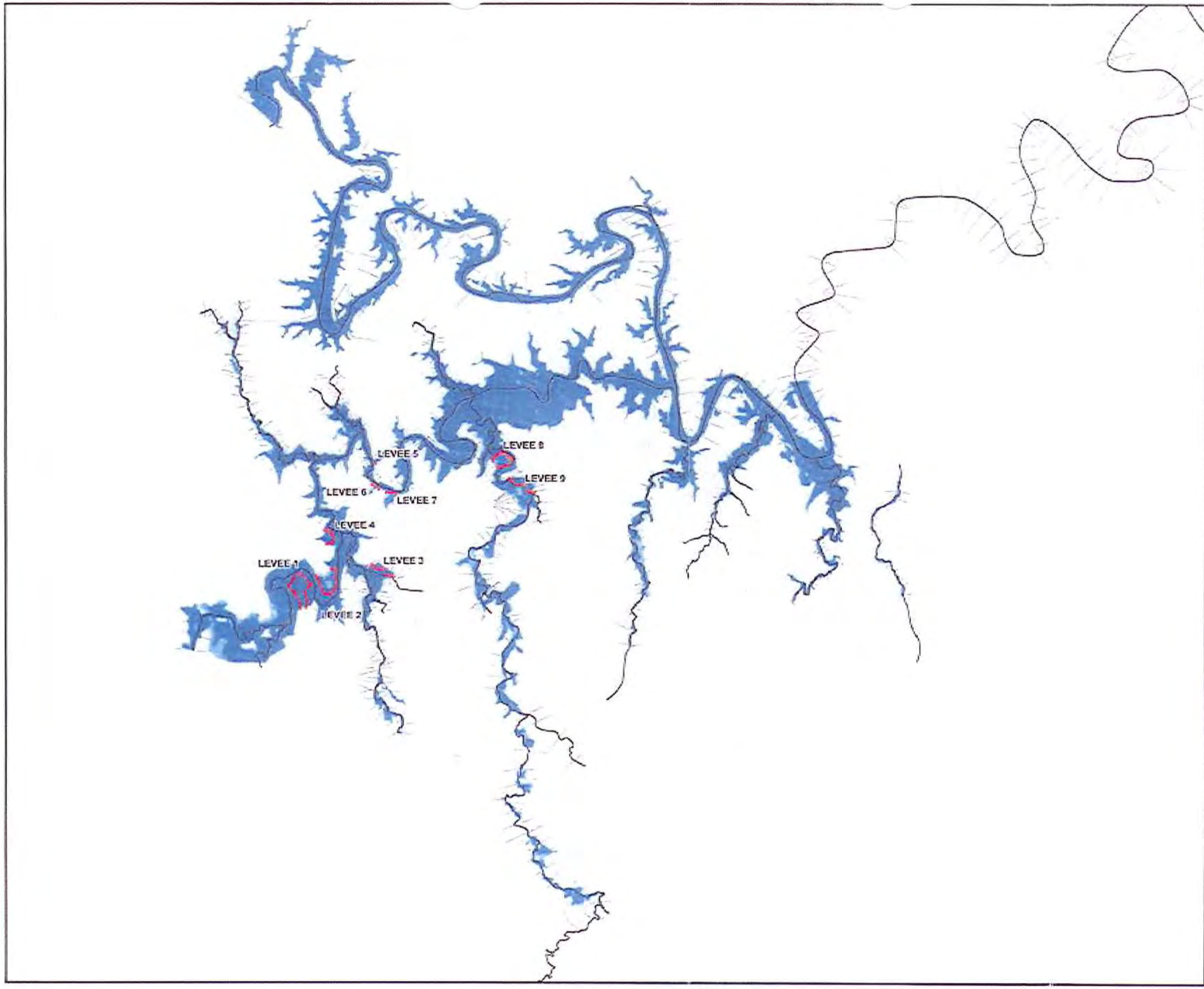
11.3 Flood Mitigation

Once the extent of inundation for the 100 year ARI Ultimate Catchments Conditions Case had been determined, significant flooded urbanised areas were identified. The practicality of flood mitigation measures for each of these areas was assessed and where possible a general flood mitigation option was formulated.

A number of flood mitigation measures were considered while developing these options, these were:

- Changes to Wivenhoe Dam and Somerset Dam operations
- Detention Basins
- Levees

Given that Brisbane River flooding is the most dominant flood in Ipswich City, initial dam levels and release procedures will have a significant impact on flood levels within Ipswich City. Initial estimates indicate that levels throughout Ipswich could be reduced by up to 2 metres if the dams were at 50% full at the commencement of a 100 year ARI event. As both of these dams are primarily water supply dams, the dams owner, the South East Queensland Water Board (SEQWB) would not be likely to accept this option given current and future water demands. Dam release procedures have been developed based on work that has been conducted by the Department of Natural Resources (DNR). These release procedures are designed to protect the integrity of the dams and the SEQWB would be unlikely to redefine these procedures. This flood mitigation measure was therefore not considered further.



Ipswich City Council

IPSWICH RIVERS FLOOD STUDY

100 YEAR ARI
FLOOD DEPTH/INUNDATION
SUMMARY FOR ULTIMATE
CONDITIONS CASE

FIGURE 11.1

NORTH

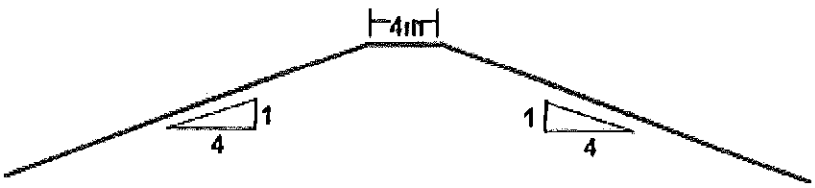
0 1 2 3 4
KILOMETRES

SINCLAIR KNIGHT MERZ

Map produced by Sinclair Knight Merz Pty Ltd
for Ipswich City Council
RE04380
inundation-01(10).wor

The construction of detention basins was also considered however this form of flood mitigation is not very practical given the flood volumes associated with Brisbane River and Bremer River flooding. As Brisbane River flooding is the predominant flooding mechanism in the tributaries detention basins on tributaries would not be an effective flood mitigation measure, therefore this measure was not considered further.
The levee option was considered to be the most appropriate measure for flood mitigation throughout the Ipswich Area. Earth or concrete levees can be used however concrete levees are significantly more expensive than the earth levees. Generally concrete levees are used where space is limited. This applies to inner city and some residential applications. A typical section of an earth levee is provided in **Figure 11.4: Typical Levee Section Schematic.**

Figure 11.4: Typical Levee Section Schematic



From **Figure 11.4** it can be seen that if the levee is 5 metres high then the width of the levee will be 44 m wide. In residential and inner city areas this width is generally too wide and concrete levees need to be used.

A total of 9 levee locations have been identified: The possible levee locations are shown on **Figure 11.1**.

The positioning of these levees were based on the number of properties affected and the practicality of constructing the levee in each location. Some of these levees require levee heights in excess of 5 m. This is not a desirable situation however levee routes were restricted due to current infrastructure. Discussion relating to each of the proposed levee routes is provided below.

Levee 1 –Suffield Road Levee – Yamanto
Levee 1 surrounds predominantly undeveloped area however some 30 existing properties are located within the area. This levee would protect in the order of 40 Ha of land from the 100 year ARI flood. The proposed levee cuts through 13 properties and easements would have to be obtained. The length of earth levee would be approximately 3 km with no concrete levee being required. The average height of the levee would be in the order of 3.0 m. The levee would also cross one roadway and a flood gate may be required for internal drainage.

Levee 2 – Chubb Street Levee - Leichhardt
Levee 2 surrounds predominantly undeveloped area however some 30 existing properties are located within the area. This levee would protect in the order of 30 Ha of land from the 100 year ARI flood. The proposed levee cuts through 10 properties and easements would have to be obtained. The length of earth levee would be approximately 2 km with no concrete levee being required. The average height of the levee would be in the order of 4.5 m. The levee would also cross two roadways and flood gates may be required for internal drainage.

Levee 3 – Turley Street Levee - Churchill
Levee 3 surrounds existing properties and some undeveloped land. There are some 30 existing properties in the area. This levee would protect in the order of 12 Ha of land from the 100 year ARI flood. The proposed levee cuts through 2 properties and easements would have to be obtained. The length of earth levee would be approximately 1 km with no concrete levee being required. The average height of the levee would be in the order of 4.0 m. The levee would also cross two roadways and flood gates may be required for internal drainage.

Levee 4 – Crescent Street Levee - Leichhardt
Levee 4 surrounds predominantly undeveloped area however some 30 existing properties are located within the area. This levee would protect in the order of 2 Ha of land from the 100 year ARI flood. The length of earth levee would be approximately 1 km with no concrete levee being required. The average height of the levee would be in the order of 6.0 m. The levee would also cross one roadway and a flood gate may be required for internal drainage.

Levee 5 – Old Railway Workshops Site Levee – North Ipswich
Levee 5 surrounds predominantly undeveloped area however some 30 existing properties are located within the area. This levee would protect in the order of 5 Ha of land from the 100 year ARI flood. The length of earth levee would be approximately 200 m with no concrete levee being required. The average height of the levee would be in the order of 2.0 m.

Levee 6 – St Mary's Church Levee - Ipswich
Levee 6 will protect some 20 existing residential properties. This levee would protect in the order of 2 Ha of land from the 100 year ARI flood. The length of earth levee would be approximately 350 m. Some concrete levee may be required. The average height of the levee would be in the order of 4.5 m.

Levee 7 – Inner City - Ipswich
Levee 7 would be to restrict backwater flooding from the Bremer River up into Marsden Parade. This levee would protect in the order of 7 Ha of land from the 100 year ARI flood. Properties in this area consist of business houses and some residential dwellings. The length of earth levee would be approximately 500 m with no concrete levee being required. The average height of the levee would be in the order of 6.0 m. The levee would also cross one roadway requiring a road raising or a gate structure.

Levee 8 – Helen Street Levee – North Booval
Levee 8 surrounds predominantly developed area with some 70 existing properties located in the area. Some undeveloped land would be made available for development should the levee be constructed. This levee would protect in the order of 20 Ha of land from the 100 year ARI flood. The proposed levee cuts through 3 properties and easements would have to be obtained. The length of earth levee would be approximately 1.5 km with no concrete levee being required. The average height of the levee would be in the order of 6.0 m. The levee would also cross one roadway and a flood gate may be required for internal drainage.

Levee 9 – Mining Street Levee - Blackstone
Levee 9 surrounds predominantly developed area with some 60 existing properties located in the area. Some 5 hectares of undeveloped land would be made available for development should the levee be constructed. This levee would protect in the order of 20 Ha of land from the 100 year ARI flood. The proposed levee cuts through 19 properties and easements would have to be obtained. The length of earth levee would be approximately 1.2 km with no concrete levee being required. The average height of the levee would be in the order of 6.0 m. The levee would also cross one roadway and floodgates may be required for internal drainage.

11.4 Discussion

Each of the proposed levee options presented above should only be considered preliminary. Some of these options may be costly and the resulting benefit/cost ratio may be low. If any of these levees are to be considered further a detailed analysis should be undertaken investigating hydraulics, environmental, financial and social issues.

Modelling of these options has not been undertaken as there would be little benefit in conducting modelling until final levee locations and routes have been determined. This work would be better conducted at a later stage of the study. Preliminary investigations indicate that the proposed levee options presented in this report would be likely not have a major impact on flood levels.

12. References

1. South East Queensland Water Board, 'Brisbane River Flood Hydrology - Runoff Routing Model Calibration', Volumes I and II, Qld DPI-Water Resources, September 1991.

2. Hausler G and Porter N, 'Report on the Hydrology of Wivenhoe Dam' Qld DPI-Water Resources, 1977.

3. Weeks W D, 'Wivenhoe Dam Design Flood Study', Qld DPI-Water Resources, 1983.

4. Deen A R, Craig R W and Sable I C, 'Hawkesbury River Flood Model', Hydrology and Water Resources Symposium, Canberra 1988.

5. Australian Rainfall and Runoff, Institution of Engineers, Australia 1987.

6. South East Queensland Water Board 'Brisbane River Flood Hydrology - Interim Report on Design Flood Estimation', by Qld DPI-Water Resources, March 1993.

7. South East Queensland Water Board 'Brisbane River Flood Hydrology - Final Report on Downstream Flooding Estimation', by Qld DPI-Water Resources, August 1993.

8. SEQWB 'Wivenhoe Dam - Moreton Bay Hydraulic Models. Model Calibration Volume III, Appendix II Derivation of Wivenhoe Dam Releases' by Qld DPI-Water Resources, October 1994.

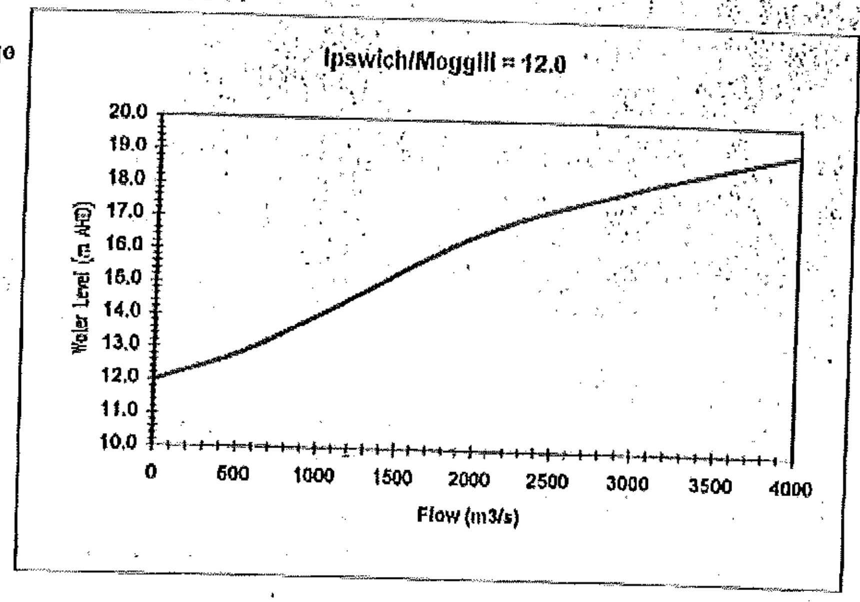
9. Bureau of Meteorology 'Severe Weather and Flooding South East Queensland May 1996' July 1996.

Appendix A - Brisbane River Catchment Rating Curves

Bremer River at IPSWICH - 143911

MOGGILL = 12.0

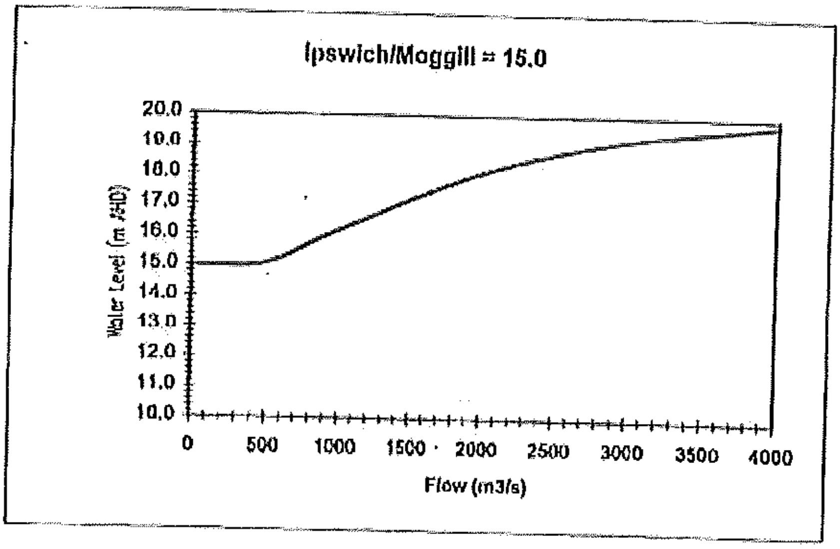
Level (m)	Discharge (m^3/s)
12	0
12.8	500
14	1000
16.5	2000
18	3000
19.2	4000



Bremer River at IPSWICH - 143911

MOGGILL = 15.0

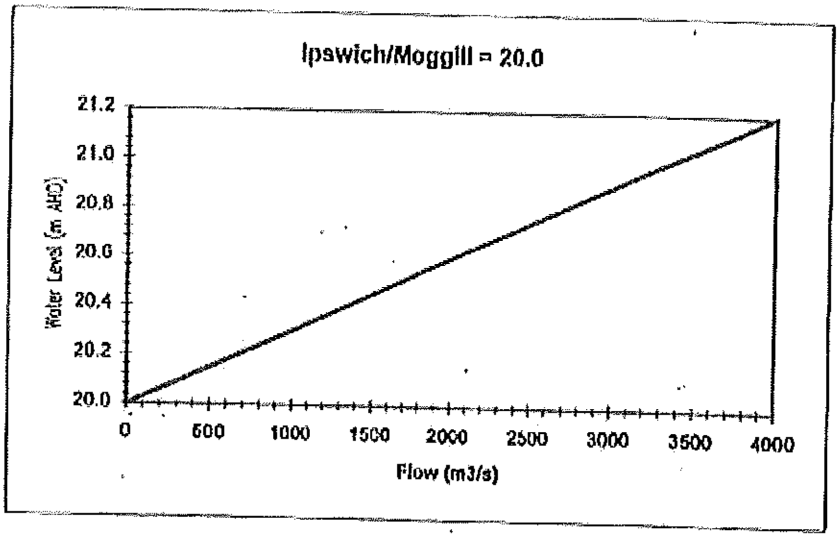
Level (m)	Discharge (m^3/s)
15	0
15.1	500
16.2	1000
18.1	2000
19.2	3000
19.8	4000



Bremer River at IPSWICH - 143911

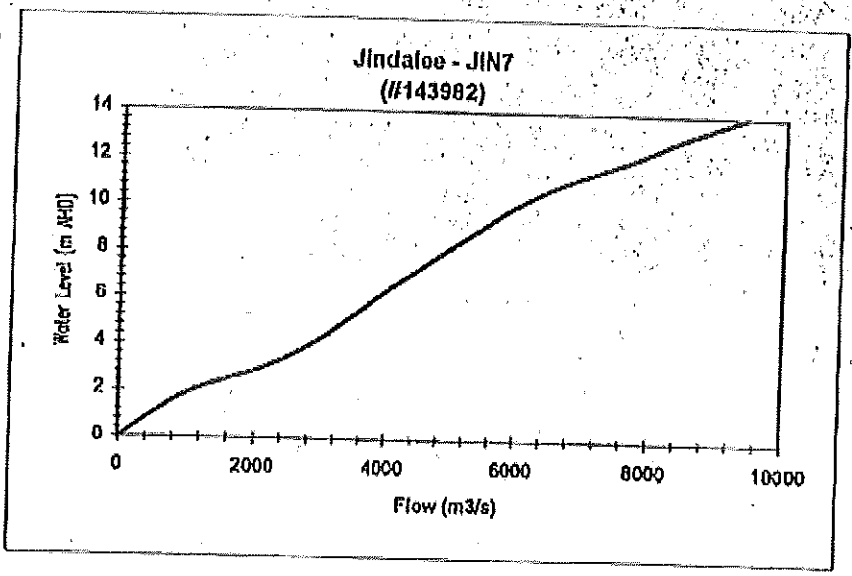
MOGGILL = 20.0

Level (m)	Discharge (m^3/s)
20	0
21.2	4000



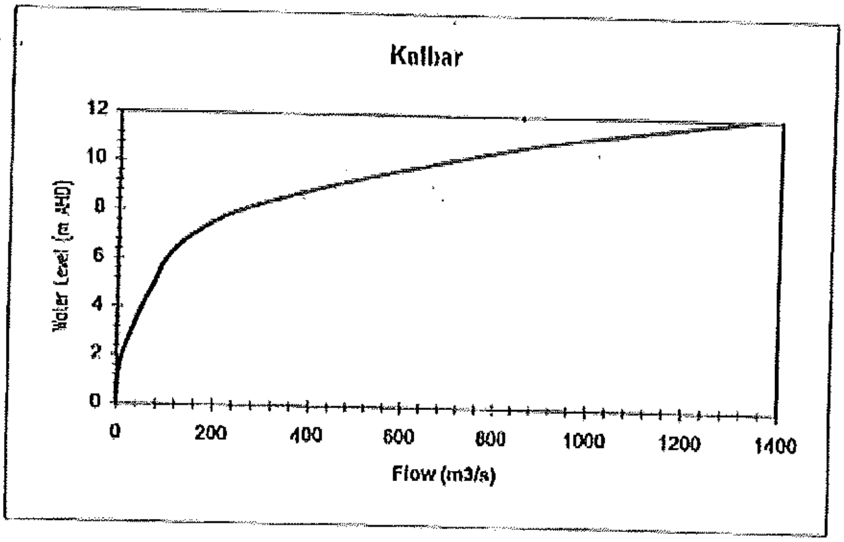
BRISBANE RIVER at JINDALEE - JIN7

Level (m)	Discharge (m^3/s)
0	0
1	500
2	1100
3	2140
4	2860
5	3380
6	3860
7	4370
8	4890
9	5440
10	6000
11	6710
12	7670
13	8470
14	9400



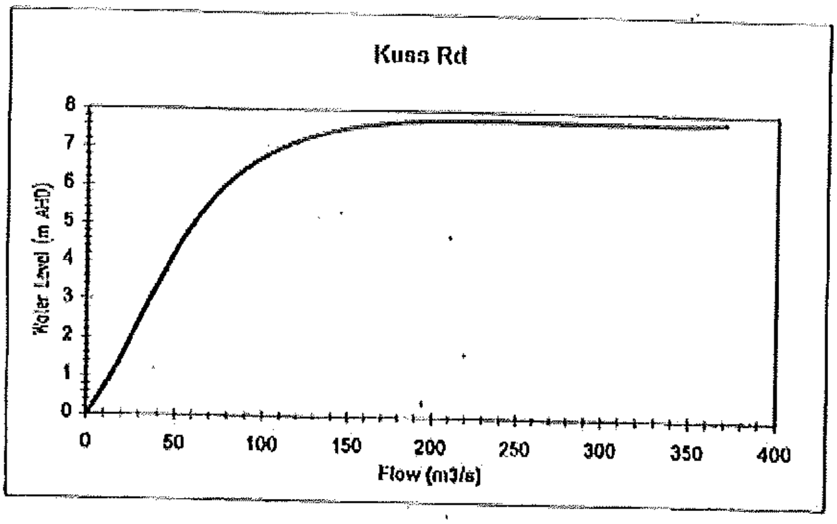
WARRILL CK at KALBAR

Level (m)	Discharge (m^3/s)
0	0
1	1
2	10
3	30
4	50
5	75
6	100
7	166
8	250
9	430
10	670
11	950
12	1350



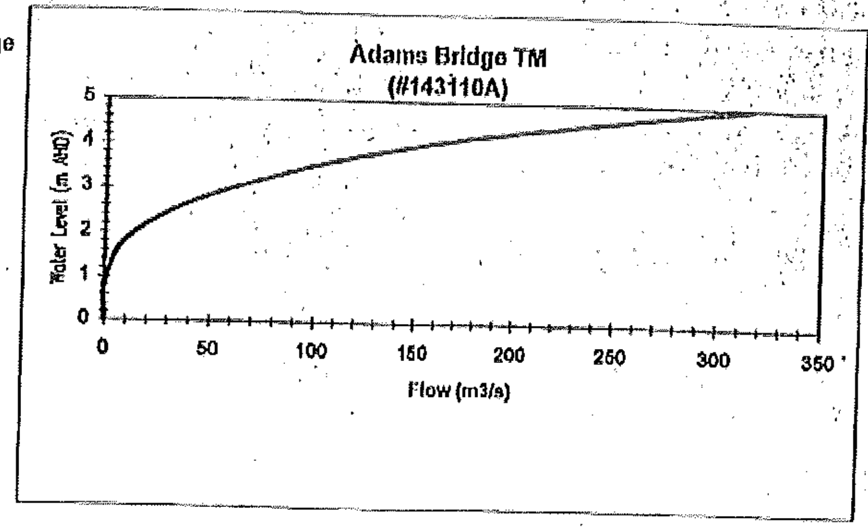
BREMER RIVER at KUSS RD

Level (m)	Discharge (m^3/s)
0	0
7	110
7.8	370



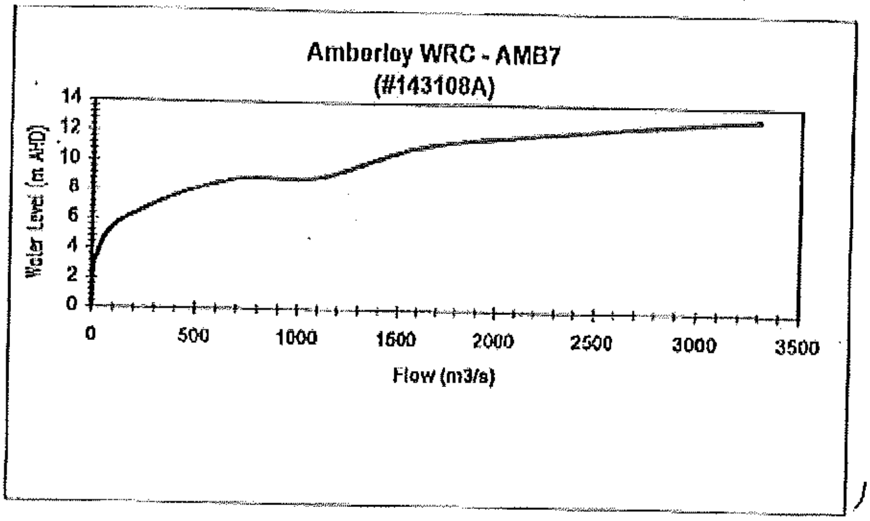
Bremer River at ADAMS BRIDGE TM - WAL4

Level (m)	Discharge (m^3/s)
0	0
1	0.5
2	14
3	60
4	150
5	316



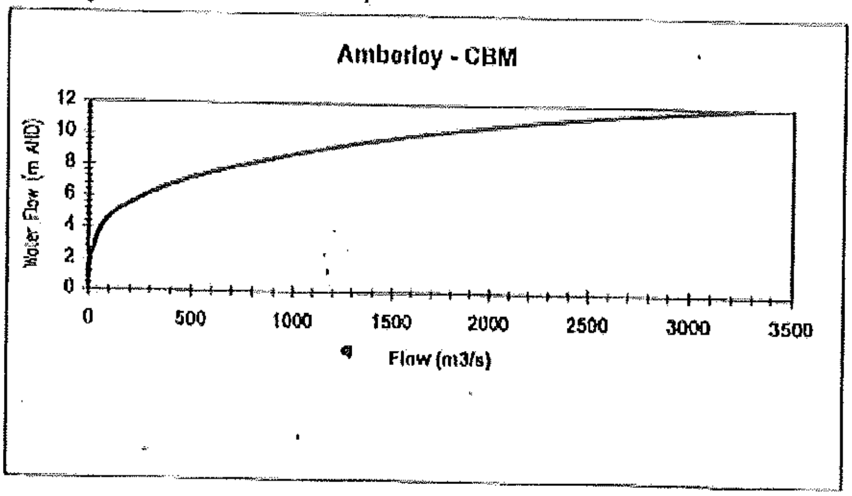
Warrill Creek at Amberley WRC - AMB7

Level (m)	Discharge (m^3/s)
0	0
1.8	1
2.8	5
3.8	30
4.8	60
5.8	130
6.8	265
7.9	450
8.9	730
9	1100
11.1	1600
12.1	2300
13.2	3300



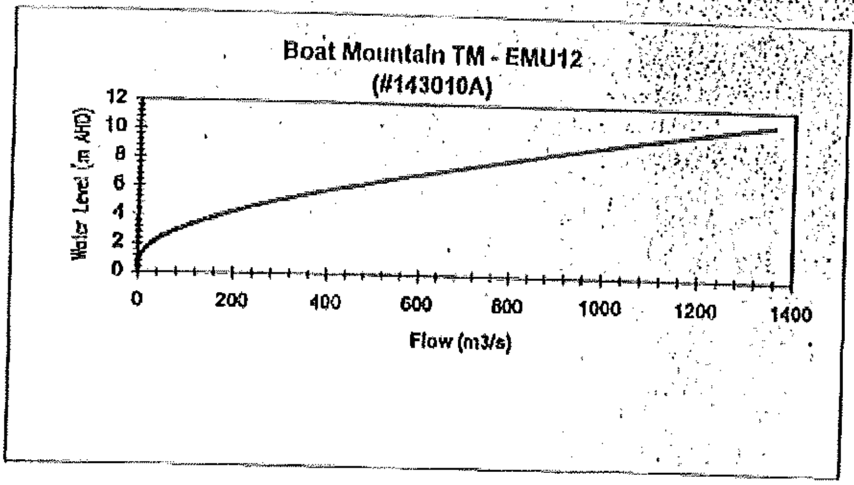
Warrill Creek at Amberley - CBM

Level (m)	Discharge (m^3/s)
1	0
2	5
3	30
4	60
5	130
6	265
7	450
8	730
9	1100
10	1600
11	2300
12	3300



Emu Creek at BOAT MOUNTAIN TM - EMU12

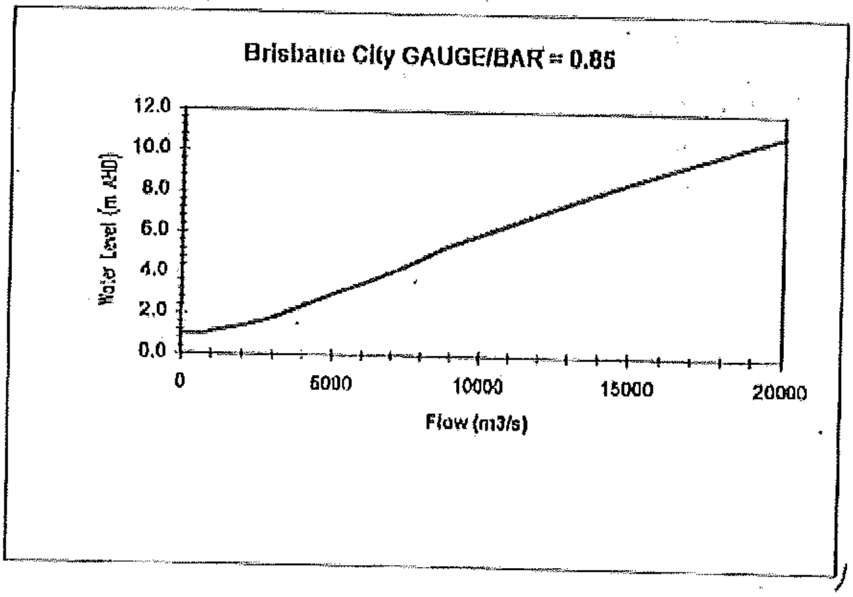
Level (m)	Discharge (m^3/s)
0	0
1	1
2	27
3	83
4	172
5	284
6	427
7	592
8	775
9	958
10	1150
11	1356



Brisbane City GAUGE

BAR = -1.15
AHD=GAUGE D

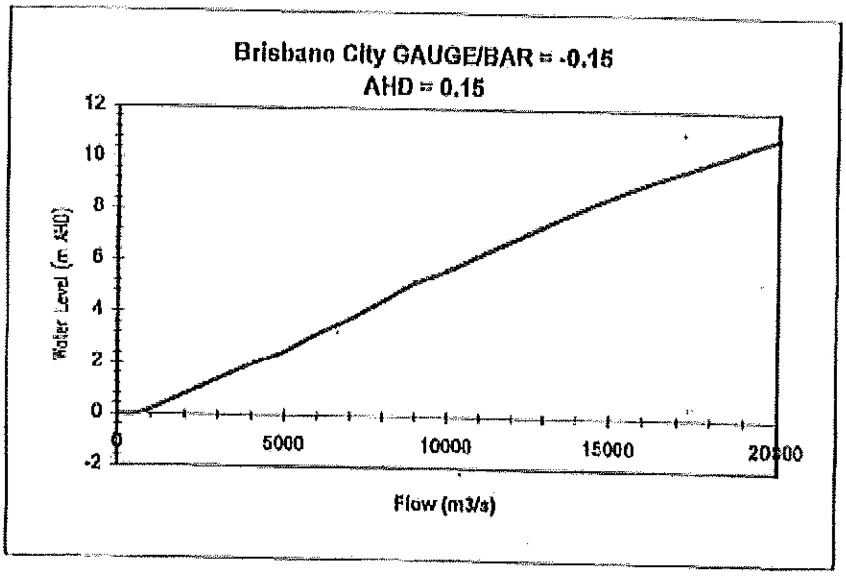
Level (m)	Discharge (m^3/s)
-0.9	0
-0.7	500
-0.4	1000
0.3	2000
1	3000
1.6	4000
2.3	5000
2.9	6000
3.5	7000
4.2	8000
4.9	9000
5.5	10000
8.6	15000
11	20000



Brisbane City GAUGE

BAR = 0.15
AHD=0.15

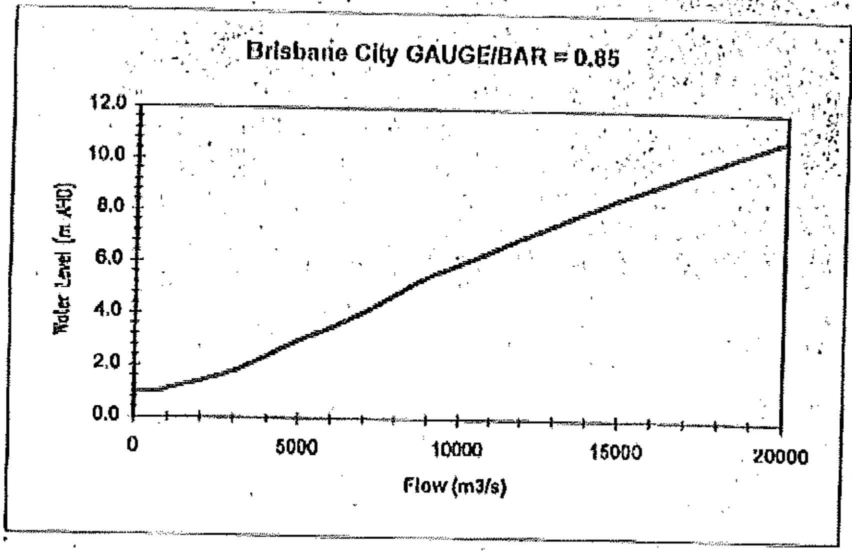
Level (m)	Discharge (m^3/s)
0	0
0.01	500
0.2	1000
0.8	2000
1.4	3000
2	4000
2.6	5000
3.2	6000
3.8	7000
4.5	8000
5.2	9000
5.7	10000
8.6	15000
11	20000



Brisbane City GAUGE

BAR = 0.85

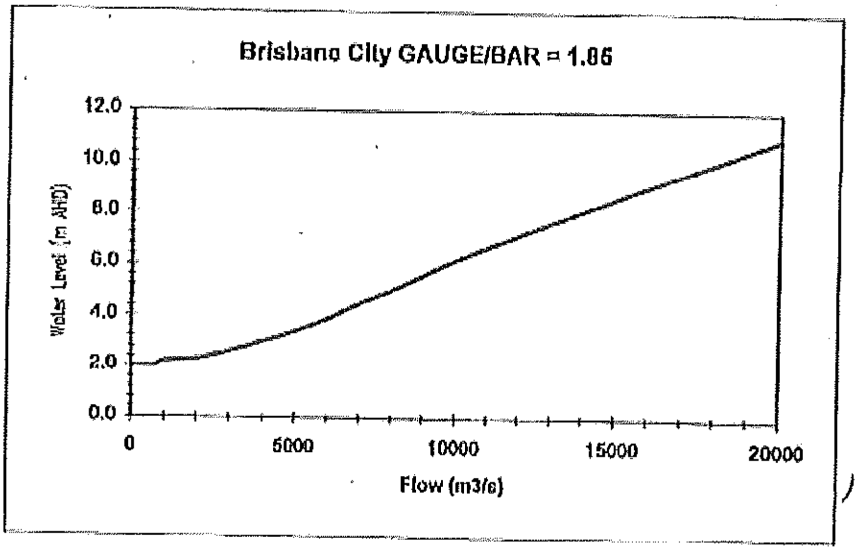
Level (m)	Discharge (m^3/s)
1	0
1.01	800
1.1	1000
1.4	2000
1.8	3000
2.4	4000
3	5000
3.5	6000
4.1	7000
4.8	8000
5.5	9000
6	10000
8.6	15000
11	20000



Brisbane City GAUGE

BAR = 1.85

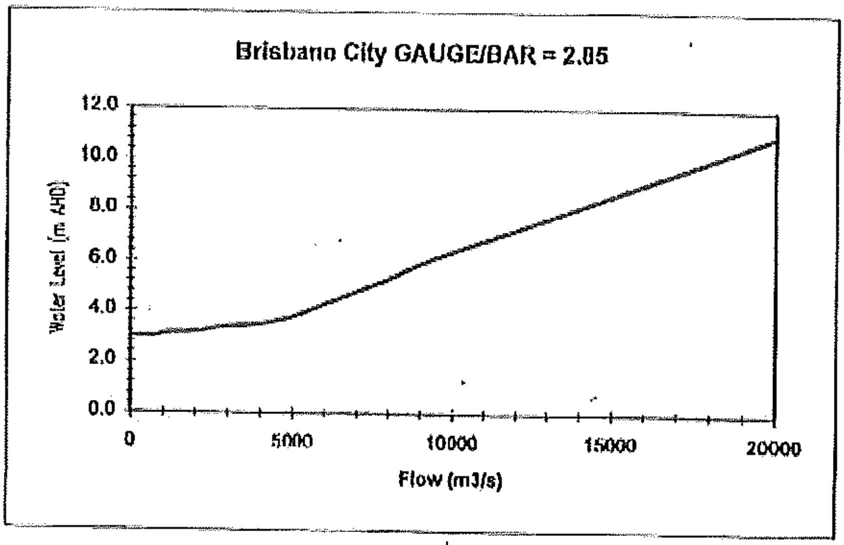
Level (m)	Discharge (m^3/s)
2	0
2.01	700
2.2	1000
2.3	2000
2.6	3000
3	4000
3.4	5000
3.9	6000
4.5	7000
5	8000
5.6	9000
6.2	10000
8.6	15000
11	20000



Brisbane City GAUGE

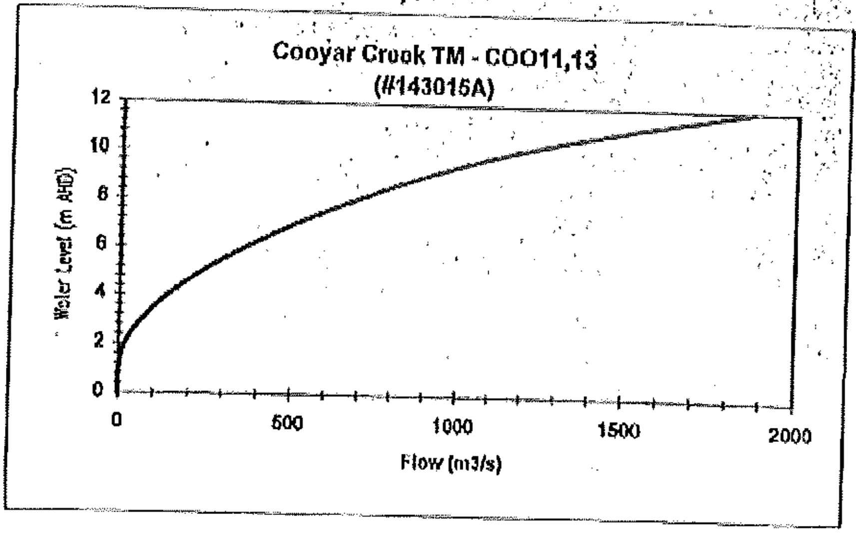
BAR = 2.85

Level (m)	Discharge (m^3/s)
3	0
3.01	800
3.1	1000
3.2	2000
3.4	3000
3.5	4000
3.8	5000
4.3	6000
4.8	7000
5.3	8000
5.9	9000
6.4	10000
8.6	15000
11	20000



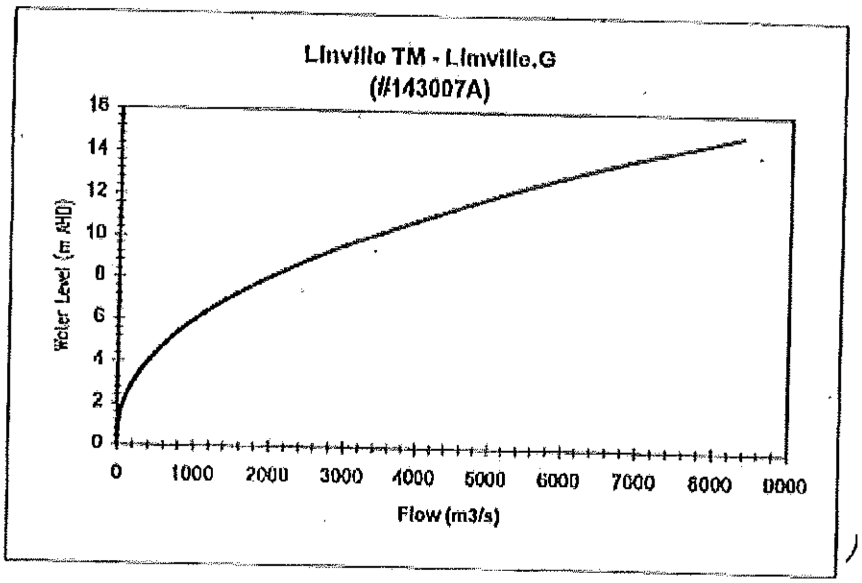
Cooyar Creek at COOYAR CREEK TM - COO11,13

Level (m)	Discharge (m^3/s)
0	0
1	1
2	15
3	65
4	139
5	237
6	361
7	511
8	687
9	889
10	1149
11	1404
12	1873



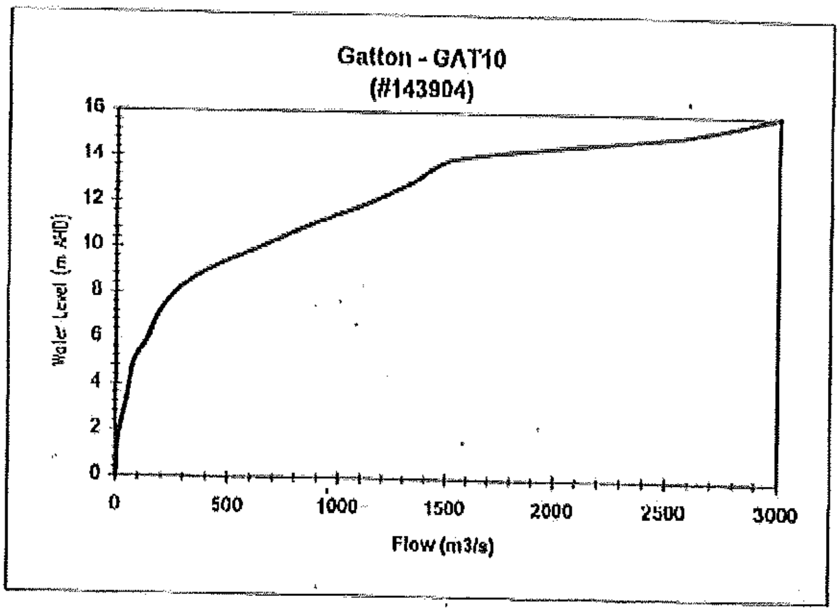
BRISBANE at LINVILLE TM - LIMVILLE.G

Level (m)	Discharge (m^3/s)
0	0
1	3
2	64
3	195
4	390
5	657
6	1000
7	1439
8	1966
9	2586
10	3299
11	4108
12	5016
13	6024
14	7134
15	8348



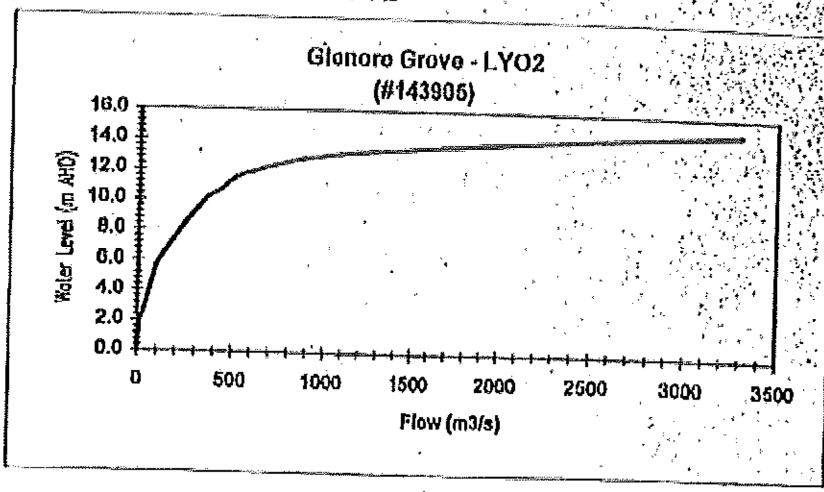
LOCKYER CREEK at GATTON - GAT10

Level (m)	Discharge (m^3/s)
0	0
1	5
2	15
3	40
4	60
5	80
6	140
7	180
8	260
9	400
10	630
11	860
12	1125
13	1350
14	1550
15	2500
16	3000



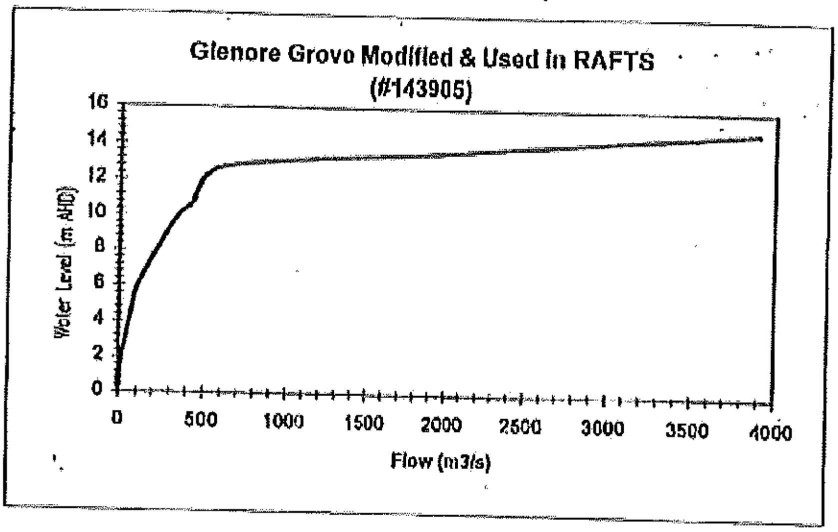
LOCKYER CREEK at GLENORE GROVE - LYO2

Level (m)	Discharge (m^3/s)
0	0
1	1
2	13
3	37
4	57
5	80
6	110
9.8	333
10.7	433
11.7	550
13	1000
14	2100
15	3300



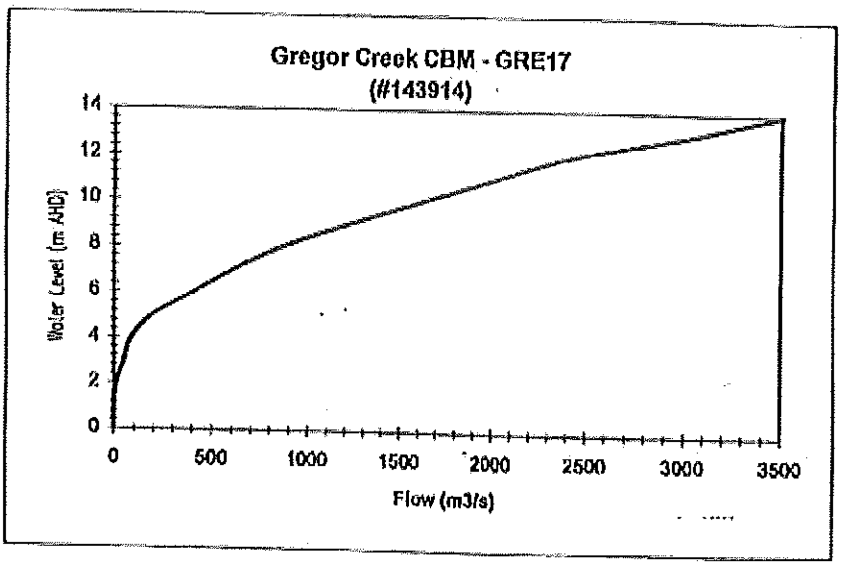
LOCKYER CREEK at GLENORE GROVE - LYO2 Modified & used in RAFTS

Level (m)	Discharge (m^3/s)
0	0
1	1
2	13
3	37
4	57
5	80
6	110
9.8	333
10.7	433
12.7	600
13.6	1950
14.3	3000
14.9	3900



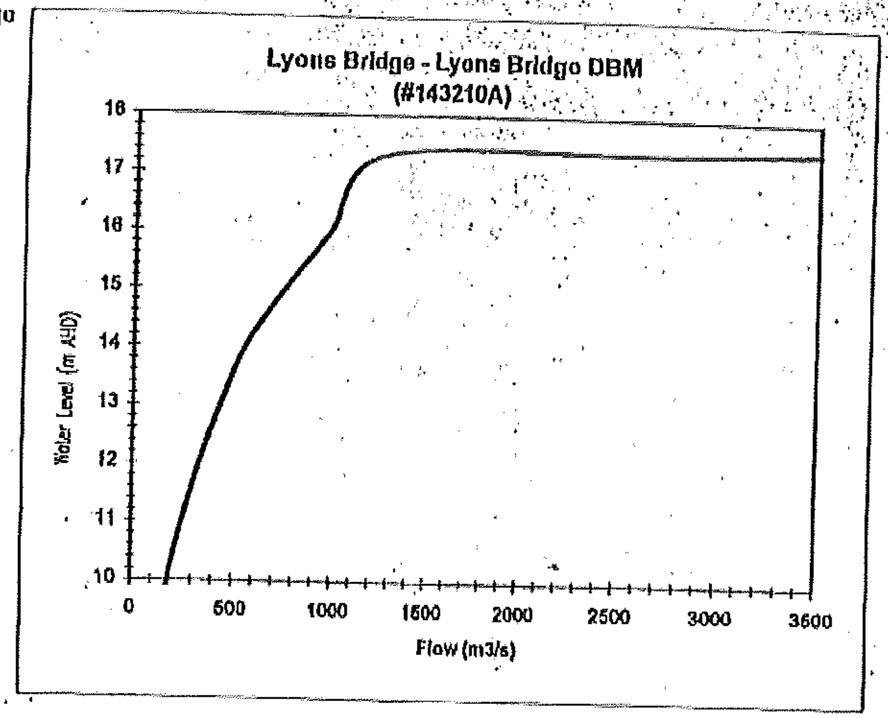
BRISBANE RIVER at GREGOR CREEK CBM - GRE 17

Level (m)	Discharge (m^3/s)
0	0
1	1
2	10
3	50
4	85
5	190
6	400
7	600
8	850
9	1200
10	1600
11	2000
12	2400
13	3000
14	3500



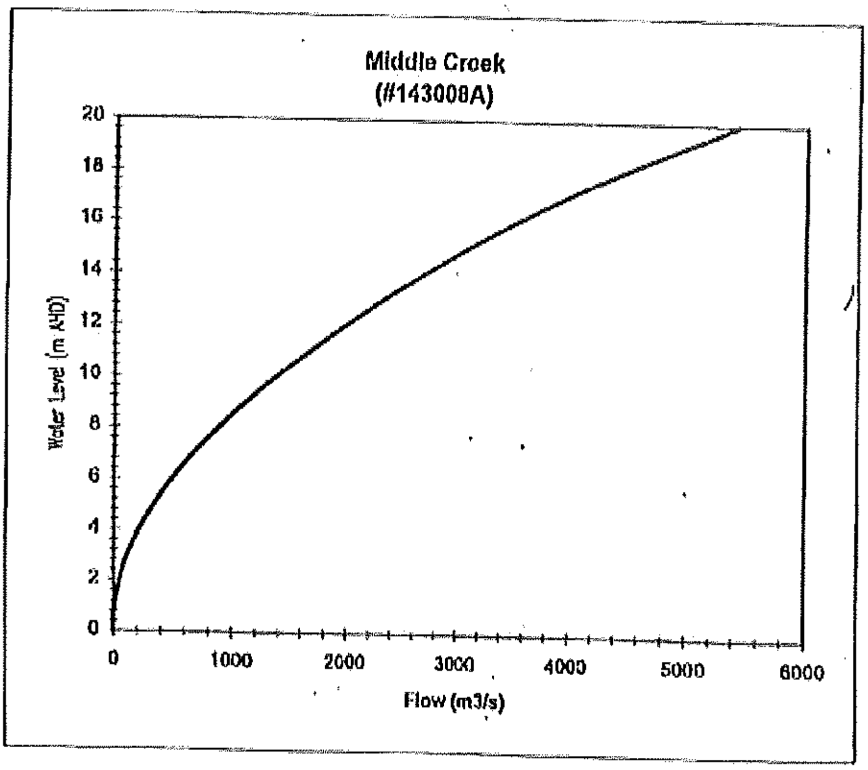
LOCKYER CREEK at LYONS BRIDGE CBM used in RAFTS - LYO6, LYONS_BR

Level (m)	Discharge (m^3/s)
0	0
1	1
2	6
3	13
4	23
5	37
6	57
7	81
8	110
9	146
10	184
11	251
12	333
13	433
14	552
15	760
16	980
17.3	1250
17.4	2650
17.5	3500



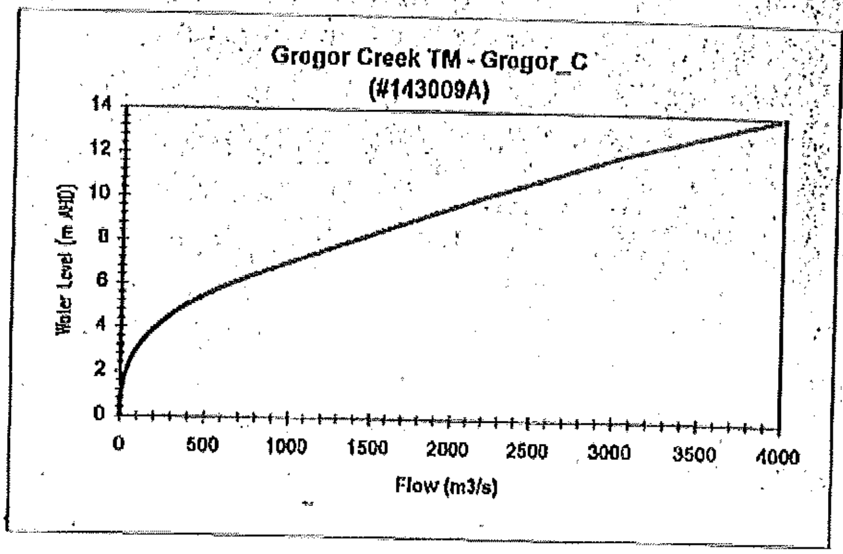
BRISBANE RIVER at MIDDLE CREEK

Level (m)	Discharge (m^3/s)
0	0
1	6
2	47
3	115
4	212
5	338
6	491
7	672
8	880
9	1115
10	1376
11	1665
12	1980
13	2321
14	2688
15	3082
16	3501
17	3946
18	4417
19	4914
20	5436



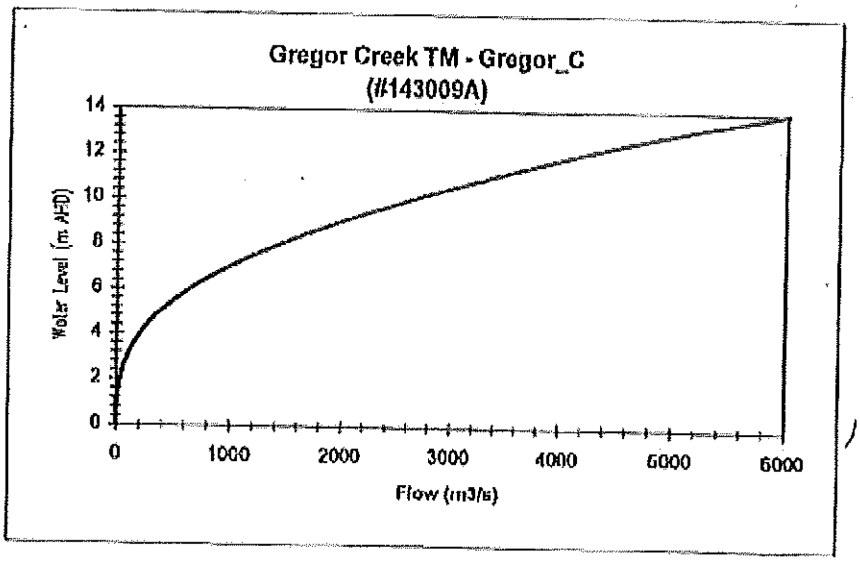
BRISBANE RIVER at GREGOR CREEK TM - GREGOR_C

Level (m)	Discharge (m^3/s)
0	0
1	2
2	29
3	93
4	206
5	381
6	638
7	981
8	1360
9	1750
10	2140
11	2580
12	3000
13	3500
14	4000



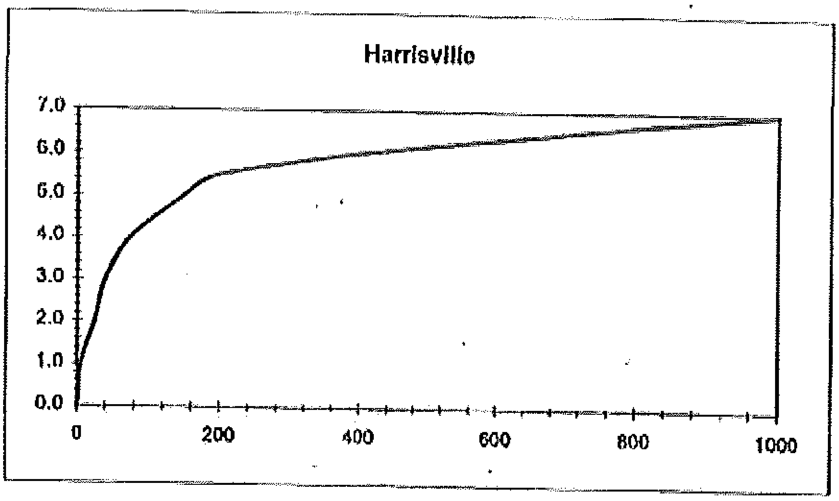
BRISBANE RIVER at GREGOR CREEK TM - GREGOR_C

Level (m)	Discharge (m^3/s)
0	0
1	2
2	29
3	93
4	206
5	381
6	638
7	981
8	1419
9	1960
10	2612
11	3328
12	4121
13	5013
14	6000



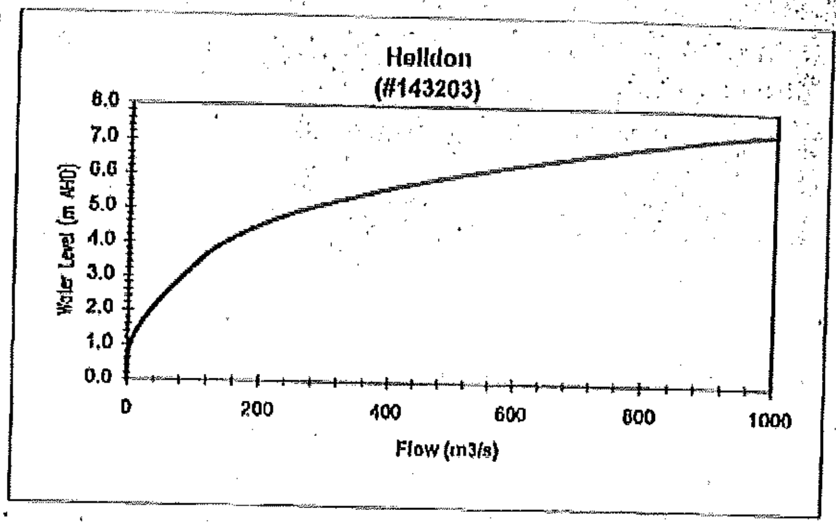
WARRILL CK at HARRISVILLE

Level (m)	Discharge (m^3/s)
0	0
1	5
2	25
3	40
4	75
5	150
5.5	200
6	400
7	1000



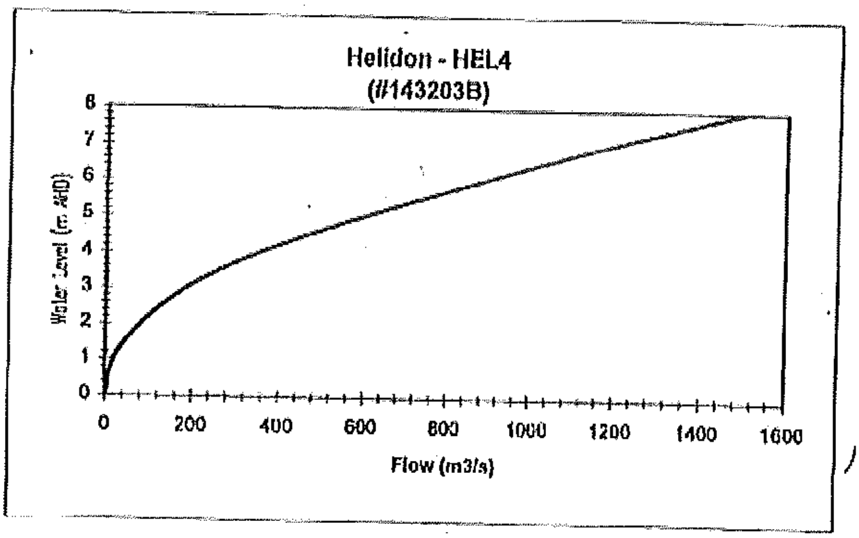
LOCKYER Ck at HELIDON

Level (m)	Discharge (m^3/s)
0	0
1	3
2	35
3	84
4	146
5	270
6	499
7	833
7.4	1000



LOCKYER CREEK at HELIDON - HEL4

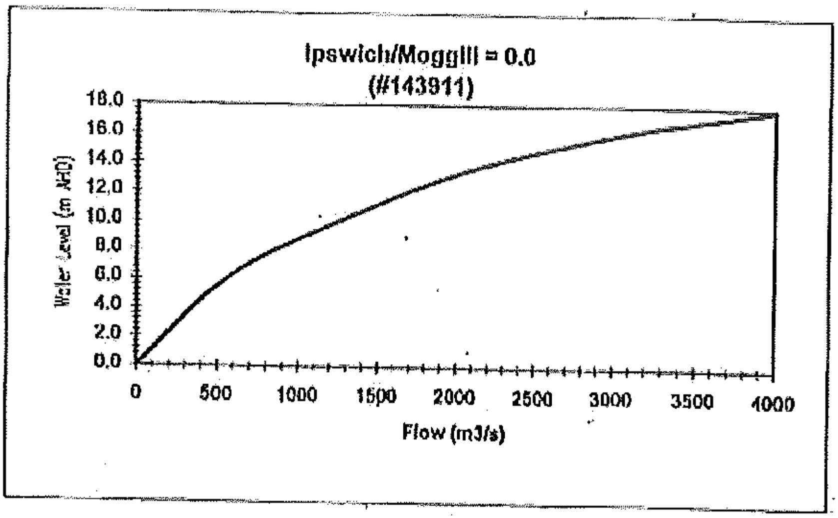
Level (m)	Discharge (m^3/s)
0	0
1	18
2	80
3	184
4	351
5	591
6	875
7	1180
8	1500



Bremer River at IPSWICH - 143911

MOGGILL = 0.0

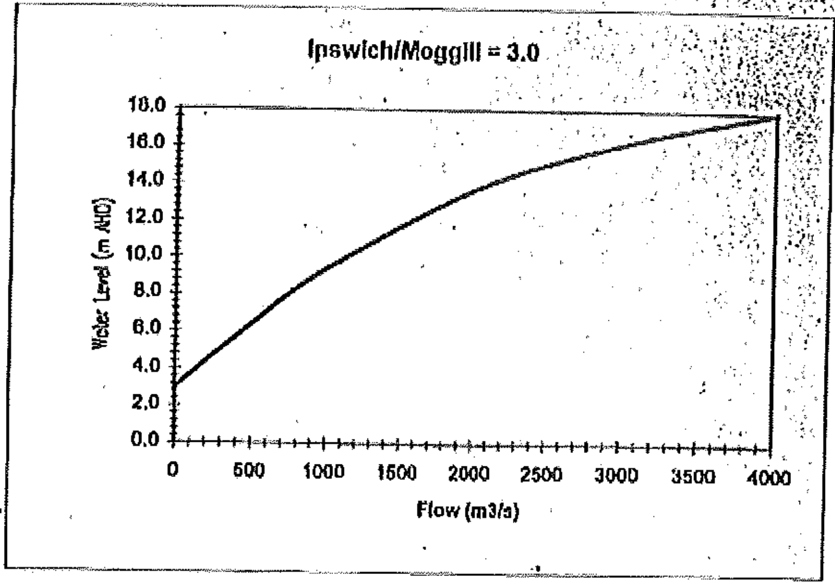
Level (m)	Discharge (m^3/s)
0	0
5.5	500
8.8	1000
13.3	2000
16	3000
17.9	4000



Bremer River at IPSWICH - 143911

MOGGILL = 3.0

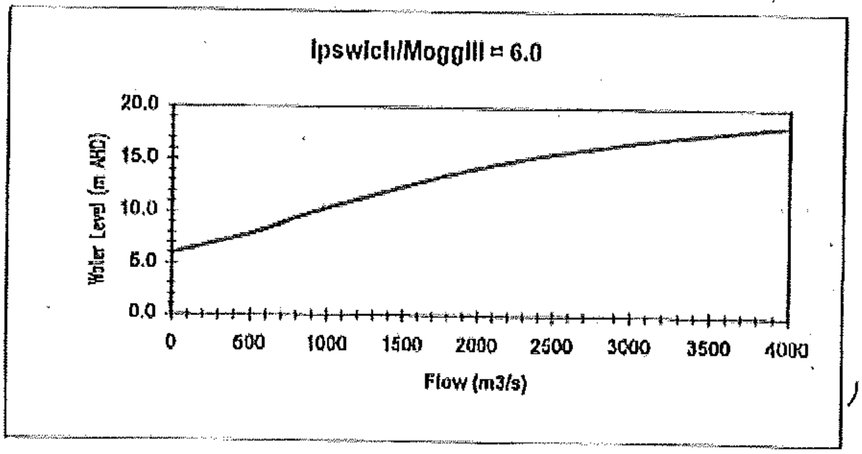
Level (m)	Discharge (m^3/s)
3	0
6.4	500
9.4	1000
13.7	2000
16.2	3000
18	4000



Bremer River at IPSWICH - 143911

MOGGILL = 6.0

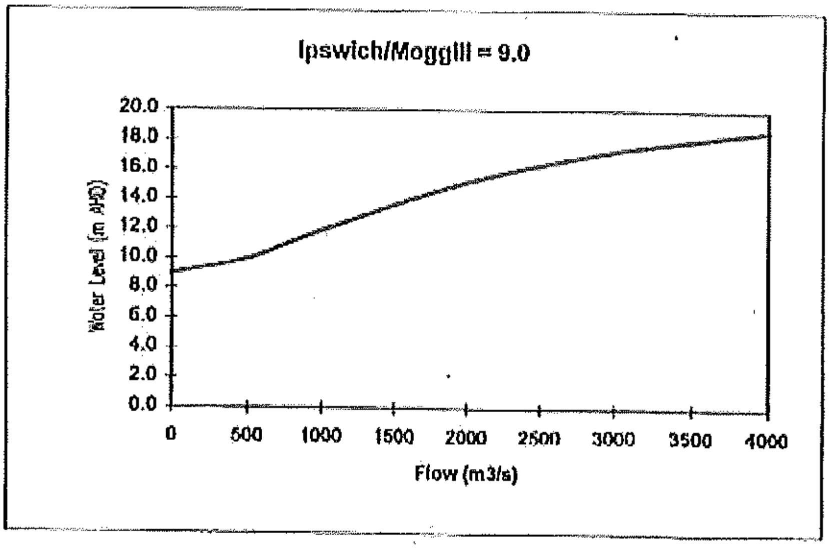
Level (m)	Discharge (m^3/s)
6	0
7.9	500
10.4	1000
14.3	2000
16.7	3000
18.4	4000



Bremer River at IPSWICH - 143911

MOGGILL = 9.0

Level (m)	Discharge (m^3/s)
9	0
10	500
11.9	1000
15.2	2000
17.3	3000
18.7	4000



Appendix B - Rainfall & Pluviometer Stations

Table B-1 - Daily Rainfall Stations

Number	Station	Period
040004	Amberley AMO	1941 - Date
040007	Bald Knob	1927 - Date
040019	Benarkin Forestry	1925 - Date
040020	Blackbutt	1900 - Date
040214	Brisbane RO	1840 - Date
040223	Brisbane AMO	1949 - Date
040030	Bryn Euryn	1917 - 1972
040289	Coalbank	1901 - Date
040050	Coominya	1916 - Date
040060	Cooyar	1895 - Date
040382	Crows Nest	1894 - Date
041028	Emu Vale Railway	1893 - Date
040225	Enoggera Reservoir	1870 - Date
040075	Esk	1886 - Date
040003	Gatton PO	1894 - Date
040082	Gatton - Lawes (CSIRO)	1897 - Date
040091	Grandchester	1894 - Date
041042	Haden	1926 - Date
040094	Harrisville	1898 - Date
040096	Helidon	1870 - Date
040101	Ipswich (Composite)	1870 - Date
040102	Jimna	1927 - Date
040104	Kalbar	1897 - Date
040110	Kilcoy	1890 - Date
040318	Kirkleagh	1953 - Date
040114	Laidley	1889 - Date
040115	Lake Manchester	1917 - Date
040120	Lowood	1887 - Date
040121	Maleny PO	1915 - Date
040133	Monsildale	1913 - 1977
040135	Moogerah Dam	1917 - Date
040136	Mooloolah	1926 - Date
040137	Moore	1913 - 1977
040139	Mt Alford	1912 - Date
040140	Mt Brisbane	1890 - Date
040142	Mt Crosby	1894 - Date
040308	Mt Glorious	1962 - Date
040247	Mt Kilcoy (Lindfield)	1923 - Date
040145	Mt Mee	1903 - Date
040147	Mt Nebo	1947 - Date
040153	Murphy's Creek	1895 - Date

Number	Station	Period
040158	Nanango	1892 - Date
040311	Nukinenda	1901 - Date
040169	Peachester	1916 - Date
040270	Ravensbourne PO	1954 - Date
040183	Rosevale	1915 - Date
040184	Rosewood	1894 - Date
040421	Spring Bluff	1895 - Date
040198	Tarome	1912 - Date
041046	The Head (Riverdale)	1913 - Date
041165	The Head (Bonnie Brae)	1913 - Date
040202	Thornton	1915 - Date
040205	Toogoolawah	1909 - Date
041103	Toowoomba (Fire Stn)	1859 - Date
040227	Wacol (Wolston Pk)	1893 - Date
040424	West Haldon	1915 - Date
040252	Woodford	1897 - Date
040258	Yarraman Ck	1913 - Date

Table B-2 - Pluviometers

Number	Station	Agency	Period of Record
040004	Amberley AMO	BM	1961 - Date
040062	Crohamhurst	BM	1960 - Date
040010	Benarkin Forestry	BM	1961 - Date
040020	Blackbutt	BM	Unknown
040214	Brisbane RO	BM	1911 - Date
040223	Brisbane AMO	BM	1950 - Date
541032	Bryn Euryn	DNR	1985 - Date
040382	Crows Nest	TCC	1965 - Date
040531	Deagon	BCC	1973 - Date
040225	Enoggera Reservoir	BCC	1961 - Date
040075	Esk	BCC	1964 - Date
040082	Gatton - Lawes CSIRO	BM	1963 - Date
040094	Harrisville PO	BM	1971 - Date
040101	Ipswich (Composite)	BM	1975 - Date
040102	Jimna PO	BM	1972 - Date
040104	Kalbar	BM	1978 - Date
040318	Kirkleagh	BM	1959 - Date
040115	Lake Manchester	BCC	1901 - Date
040133	Monsildale	BCC	1963 - 1977
040135	Moogerah Dam	BM	1959 - Date
040300	Mt Glorious	BM	1969 - Date
040526	Mt Nebo	BCC	1966 - Date
040674	Mt Stanley	BM	1977 - Date
040460	Perseverance Dam	TCC	1971 - Date
040270	Ravensbourne	TCC	1965 - Date
040076	Robyn Dale	BM	1972 - Date
040503	Rosewood	BM	1977 - Date
040241	Samford (CSIRO)	CSIRO	1967 - Date
040202	Thornton	BM	1970 - Date
040528	Three Way Catchment	BCC	1970 - Date
041407	Toowoomba	TCC	1954 - Date
040675	Townson	BM	1977 - Date
040828	Woodford (BCC)	BCC	1964 - Date
040079	Forest Hill	DNR	1894 - Date
040095	Hatton Vale	DNR	1908- Date
040107	Beaudesert	DNR	1917 - Date
040124	Marburg	DNR	1887 - Date

Table B-2 - Pluviometers (Continued)

Number	Station	Agency	Period of Record
040149	Boonah	DNR	1924 - 1990
040150	Mundoolun	DNR	1881 - Date
040154	Murrumba (Fairview)	DNR	1926 - 1974
040155	Mudtapilly	DNR	1917 - 1957
040156	Innisplain	DNR	1913 - Date
040160	Narangbar	DNR	1920 - 1987
040163	Rathdowney	DNR	1925 - 1972
040170	Crows Nest (Peachy SF)	DNR	1927 - Date
040171	Petrie (Australian Paper Mills)	DNR	1880 - Date
040179	Redbank	DNR	1888 - 1978
040180	Margate	DNR	1888 - Date
040181	Roadvale	DNR	1907 - 1983
040186	Samsonvale Composite	DNR	1910 - Date
040197	Mount Tamborine	DNR	1888 - Date
040208	Pine Mountain	DNR	1925 - Date
040212	Ascot Racecourse	DNR	1920 - Date
040213	Bald Hills	DNR	1895 - 1993
040215	Brisbane Botanic Gardens	DNR	1890 - 1984
040216	Brisbane Show Grounds	DNR	1869 - Date
040220	Goodna	DNR	1870 Date
040224	Enoggera	DNR	1899 - Date

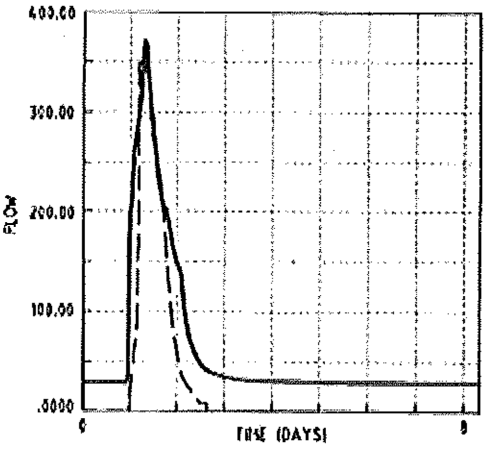
Note: BM = Bureau of Meteorology
NDR = Department of Natural Resources
TCC = Toowoomba City Council
BCC = Brisbane City Council

Appendix C - Recorded & RAFTS Predicted Hydrographs

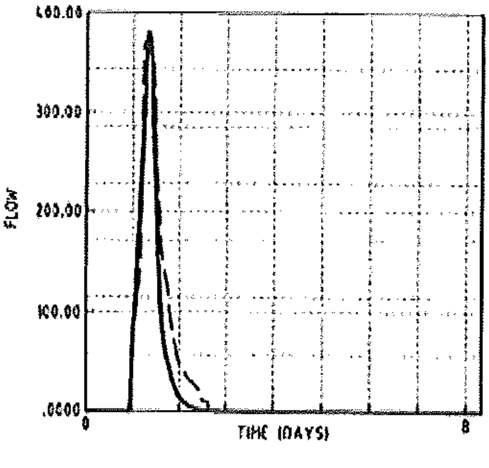
FIGURE C-1a

IPSWICH RIVERS FLOOD STUDY
DECEMBER 1991 FLOOD HYDROGRAPHS

BUNDAMBA CREEK AT BLACKSTONE ROAD



BUNDAMBA CREEK AT BRISBANE ROAD



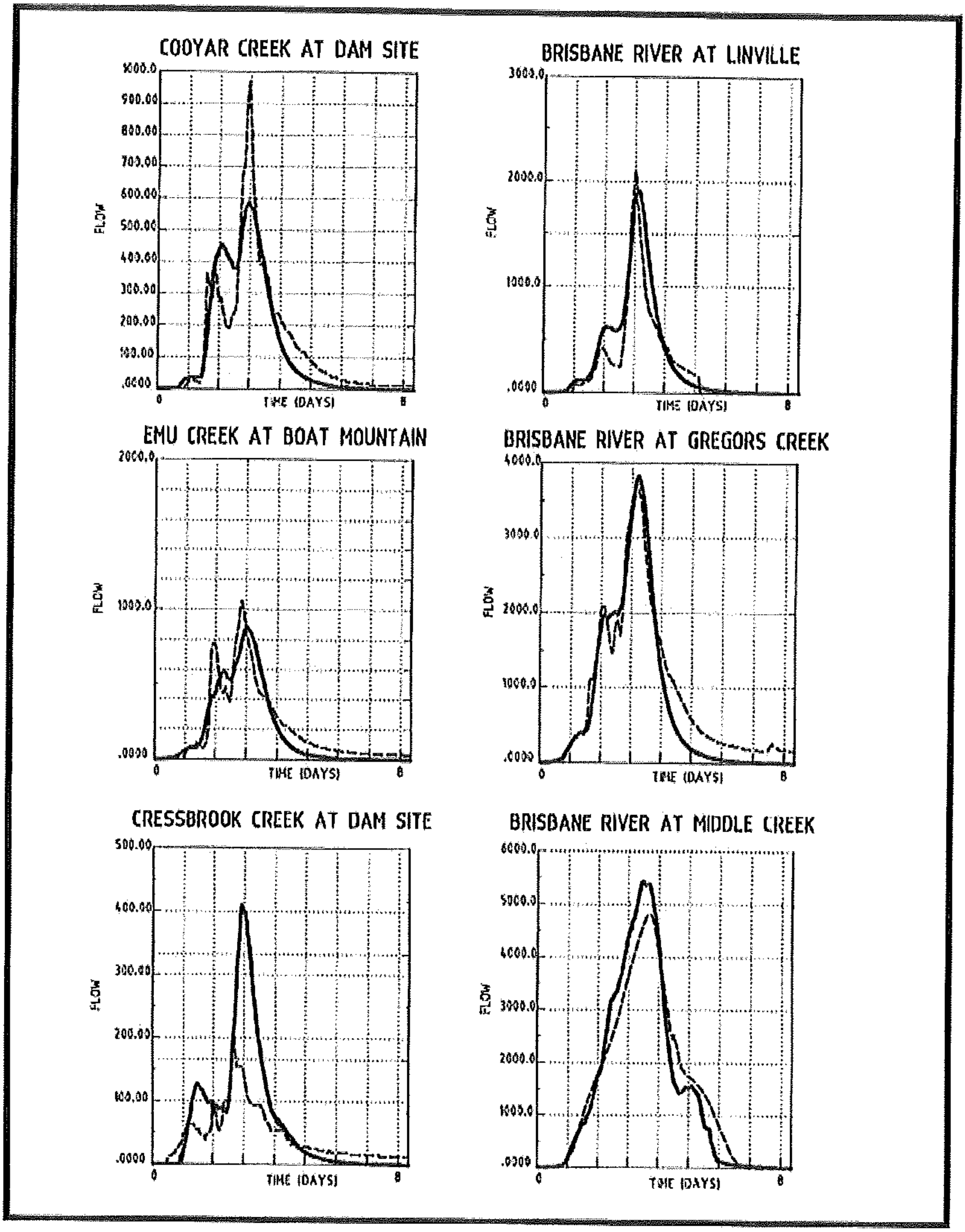
LEGEND
— — — RECORDED DISCHARGE
——— PREDICTED DISCHARGE

FILE NAME: 04390-25 DISK Nº: U:\FWUD JOB Nº: T004390 DATE: 21-05-99
PLOT SCALE: 1:100

SINCLAIR KNIGHT MERZ

FIGURE C-2a

IPSWICH RIVERS FLOOD STUDY
JANUARY 1974 FLOOD HYDROGRAPHS



LEGEND

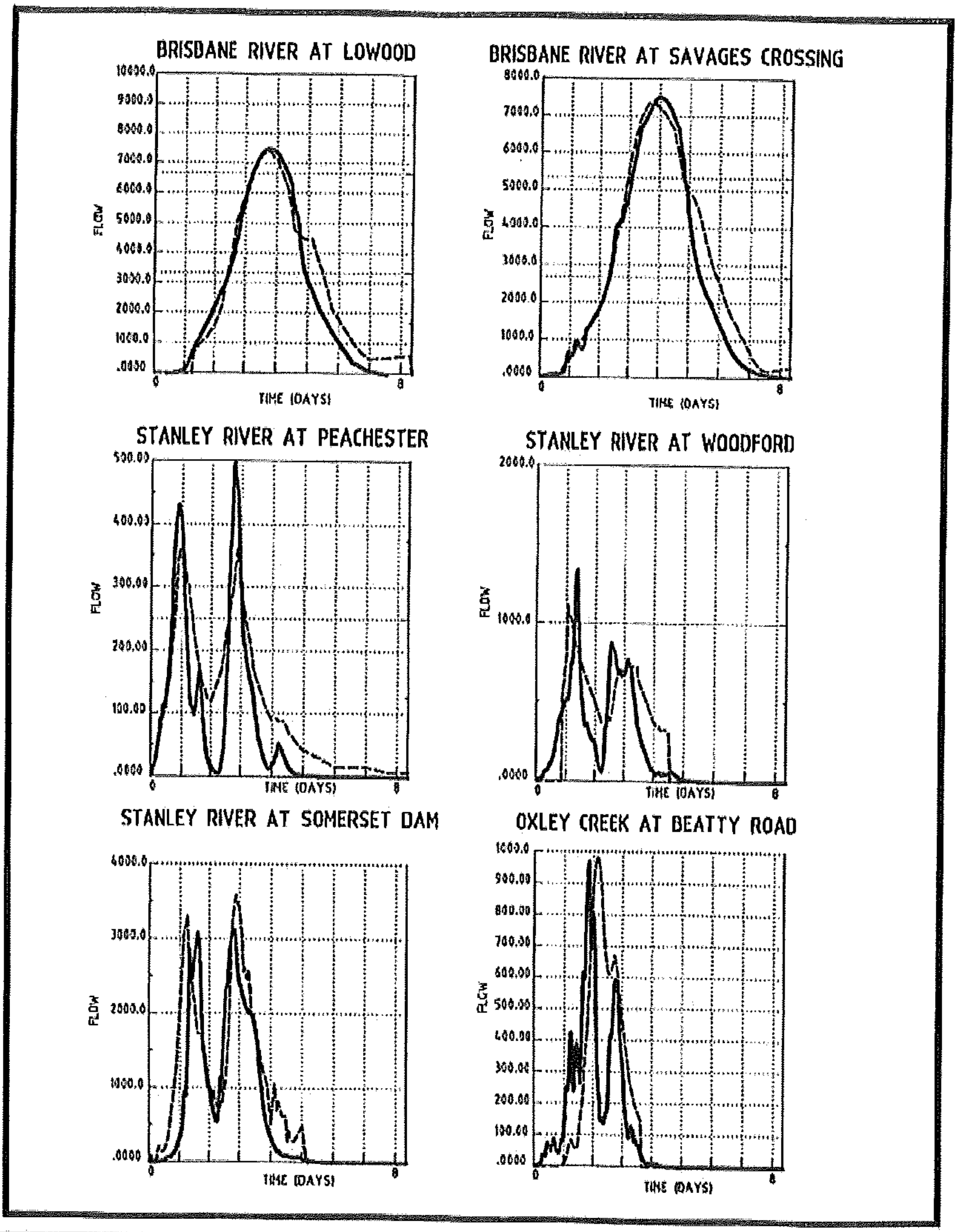
- - - - - - RECORDED DISCHARGE

———— PREDICTED DISCHARGE

FILE NAME: 04390-22 PLOT SCALE: 1:100 DISK N°: UNFWUD JOB N°: T004390 DATE: 20-05-99

SINCLAIR KNIGHT MERZ

FIGURE C-2b
IPSWICH RIVERS FLOOD STUDY
JANUARY 1974 FLOOD HYDROGRAPHS



LEGEND

- - - - - - RECORDED DISCHARGE

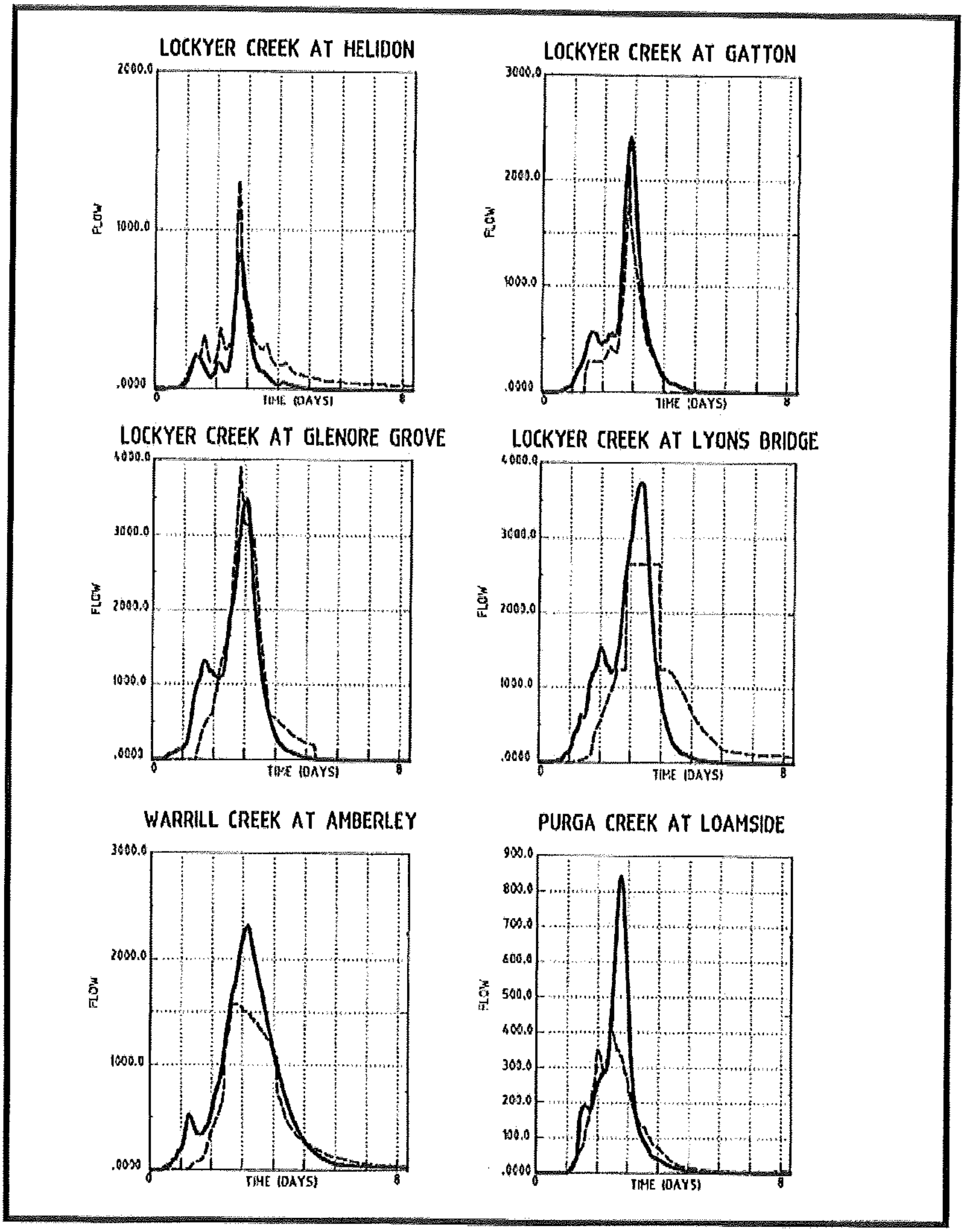
———— PREDICTED DISCHARGE

FILE NAME: 04390-22 DISK N°: U:\FWUD JOB N°: T004390 DATE: 20-05-95
PLOT SCALE: 1:300

BINCLAIR KNIGHT MERZ

FIGURE C-2c

IPSWICH RIVERS FLOOD STUDY
JANUARY 1974 FLOOD HYDROGRAPHS

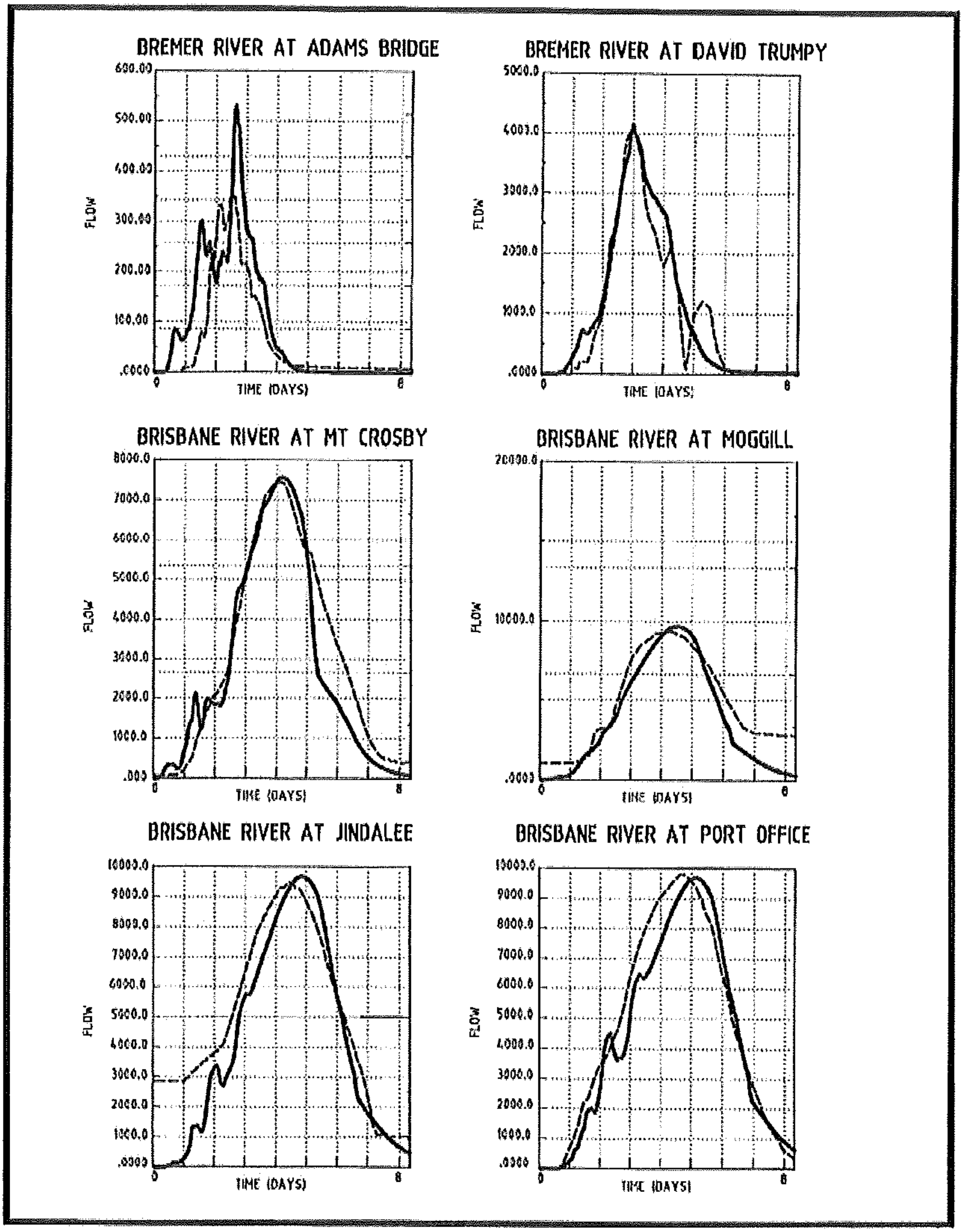


LEGEND

- - - - - - RECORDED DISCHARGE
———— PREDICTED DISCHARGE

FILE NAME: 04390-22 PLOT SCALE: 1:100 DISK Nº: UNFWUD JOB Nº: T004390 DATE: 20-05-95

FIGURE C-2d
IPSWICH RIVERS FLOOD STUDY
JANUARY 1974 FLOOD HYDROGRAPHS



LEGEND

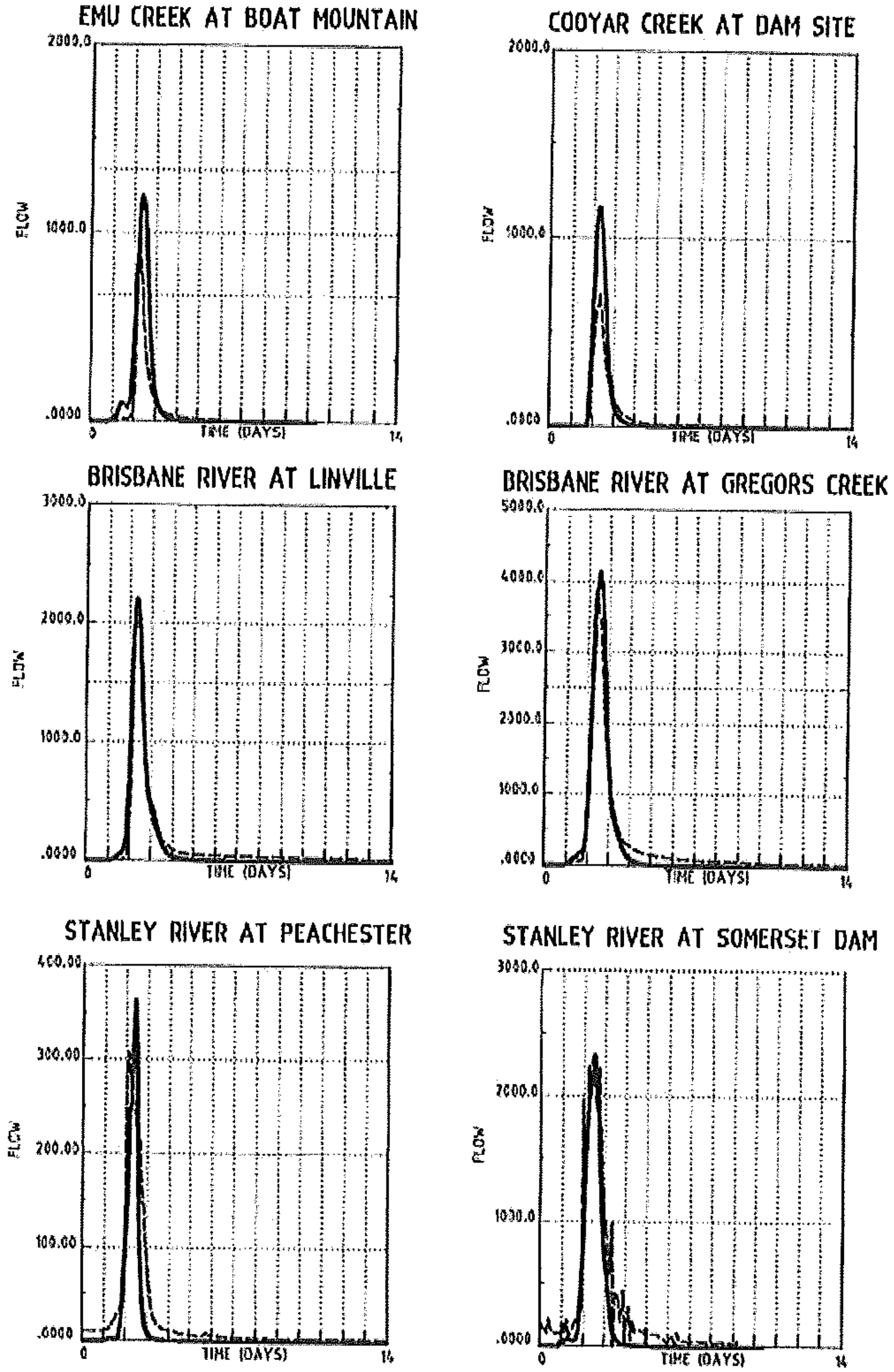
- - - - - - - - RECORDED DISCHARGE

———————— PREDICTED DISCHARGE

FILE NAME: 04390-22 PLOT SCALE: 1:100 DISK N°: UNFMUD JOB N°: T304390 DATE: 20-15-99

SINCLAIR KNIGHT MERZ

FIGURE C-3a
IPSWICH RIVERS FLOOD STUDY
JUNE 1983 FLOOD HYDROGRAPHS



LEGEND

- - - - - - RECORDED DISCHARGE

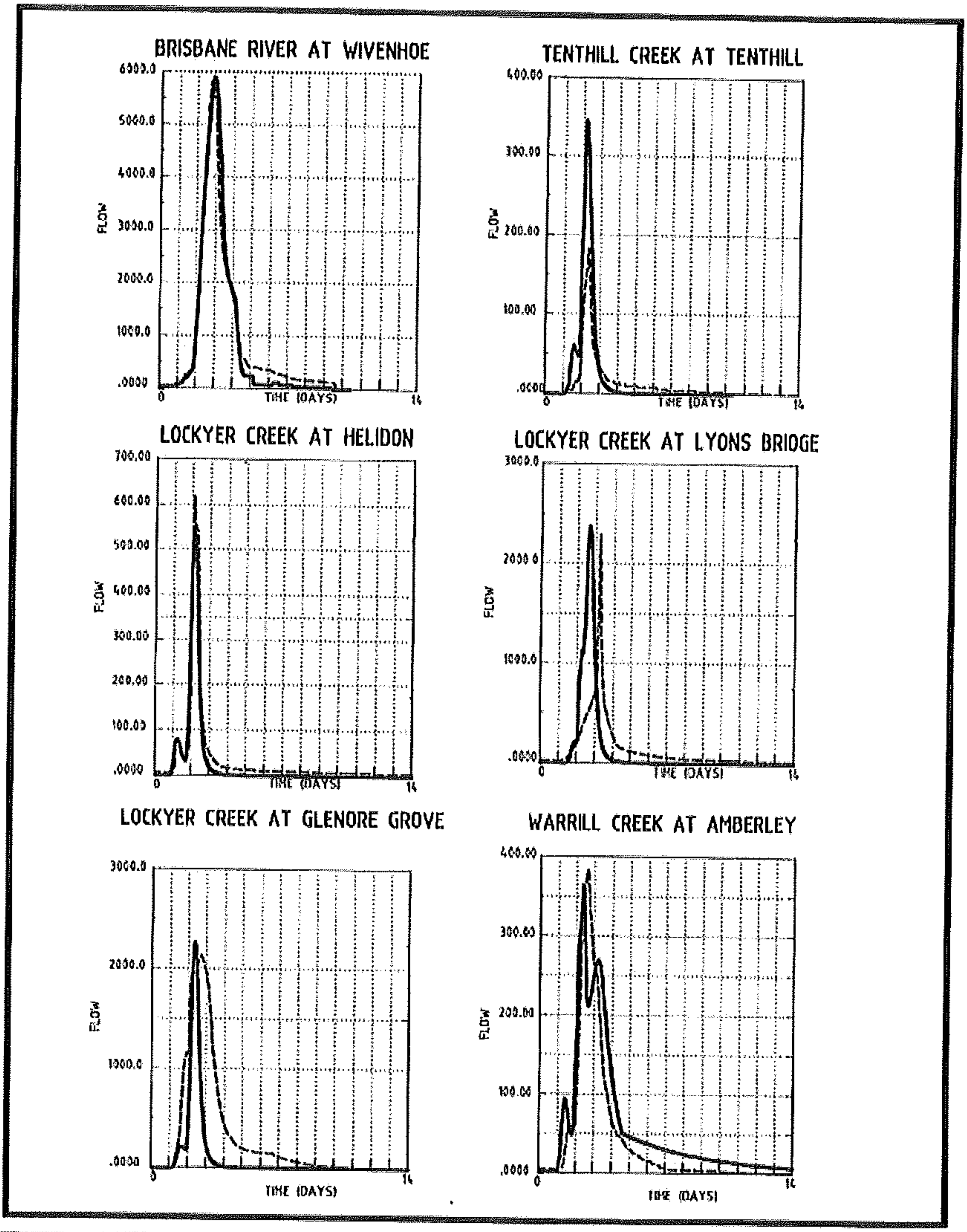
———— PREDICTED DISCHARGE

FILE NAME: 04390-23 DISK Nº: UNFWUD JOB Nº: T004390 DATE: 21-05-99
PLOT SCALE: 1:100

SINCLAIR KNIGHT MERZ

FIGURE C-3b

IPSWICH RIVERS FLOOD STUDY
JUNE 1983 FLOOD HYDROGRAPHS



LEGEND

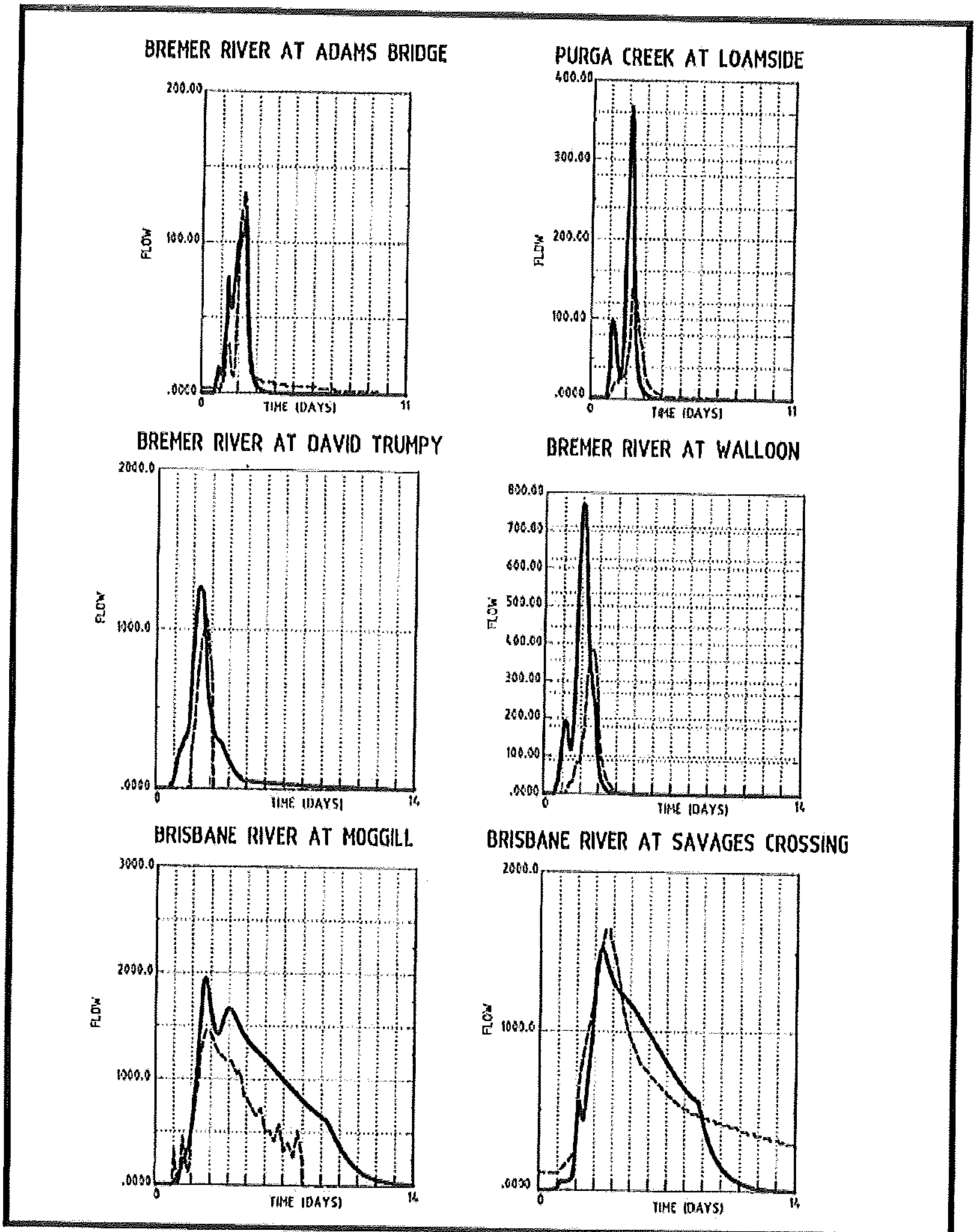
- - - - - - RECORDED DISCHARGE

———— PREDICTED DISCHARGE

FILE NAME: 04390-23 DISK N°: UNFWUD JOB N°: TE04390 DATE: 21-05-99
PLOT SCALE: 1:100

SINCLAIR KNIGHT MERZ

FIGURE C-3c
IPSWICH RIVERS FLOOD STUDY
JUNE 1983 FLOOD HYDROGRAPHS



LEGEND

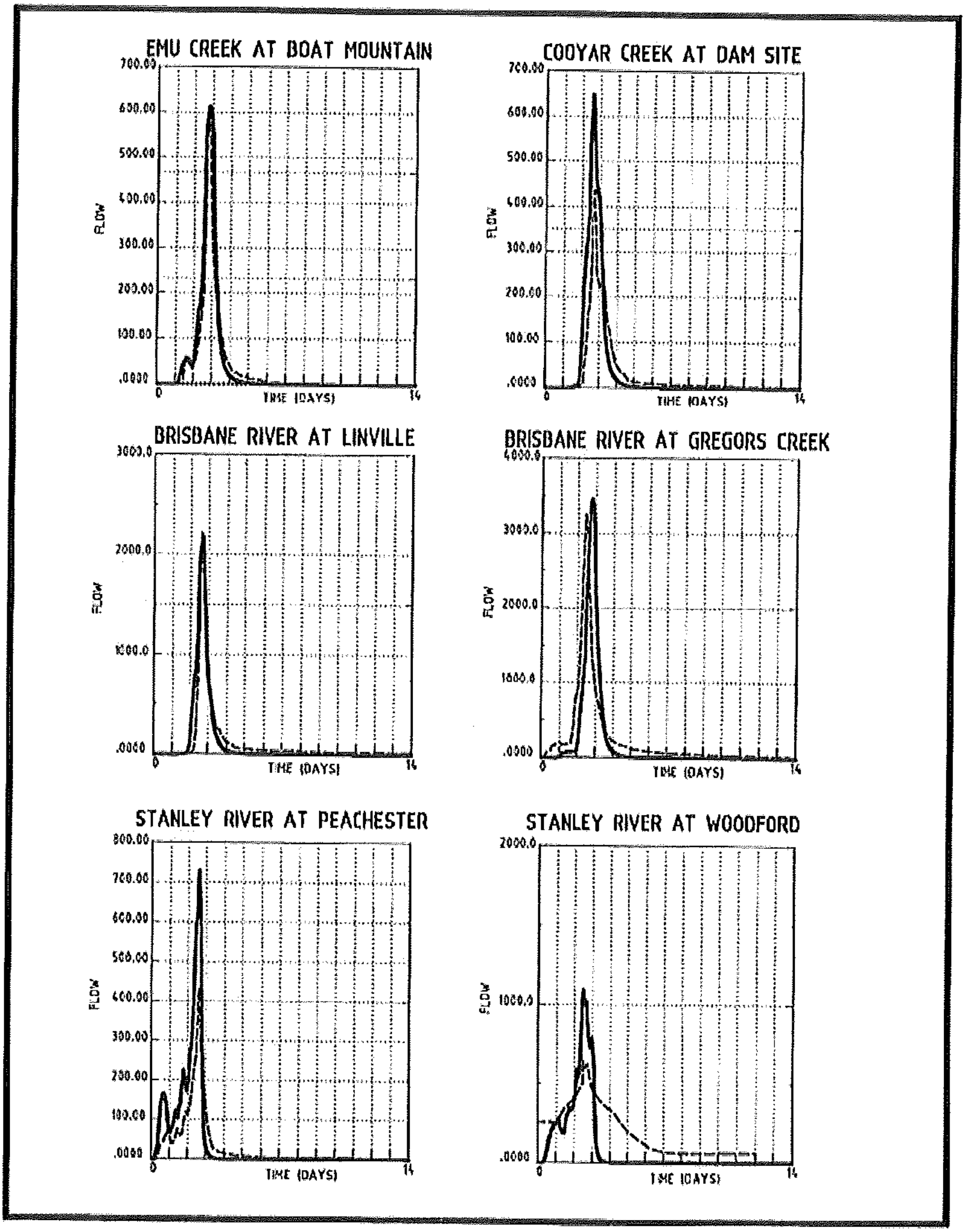
- - - - - RECORDED DISCHARGE
——— PREDICTED DISCHARGE

FILE NAME: 04390-23 PLOT SCALE: 1:100 DISK N°: U:\FWUD JOB N°: TD04390 DATE: 21-05-99

SINCLAIR KNIGHT MERZ

FIGURE C-4a

IPSWICH RIVERS FLOOD STUDY
APRIL 1989 FLOOD HYDROGRAPHS



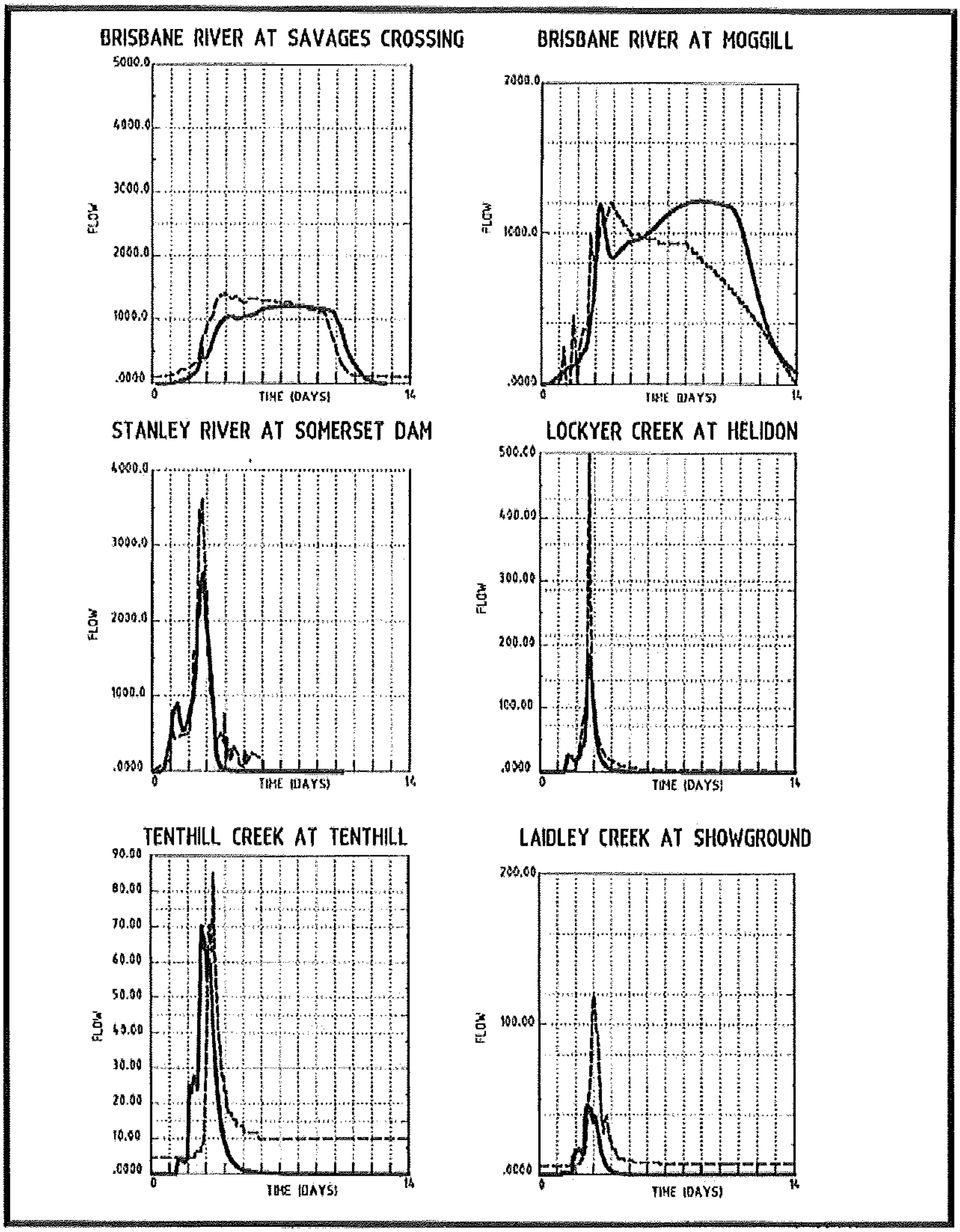
LEGEND

- - - - - - RECORDED DISCHARGE

———— PREDICTED DISCHARGE

FILE NAME: 04390-24 PLOT SCALE: 1:00 DISK Nº: UAFWLD JOB Nº: TD04390 DATE: 21-05-99

FIGURE C-4b
IPSWICH RIVERS FLOOD STUDY
APRIL 1989 FLOOD HYDROGRAPHS



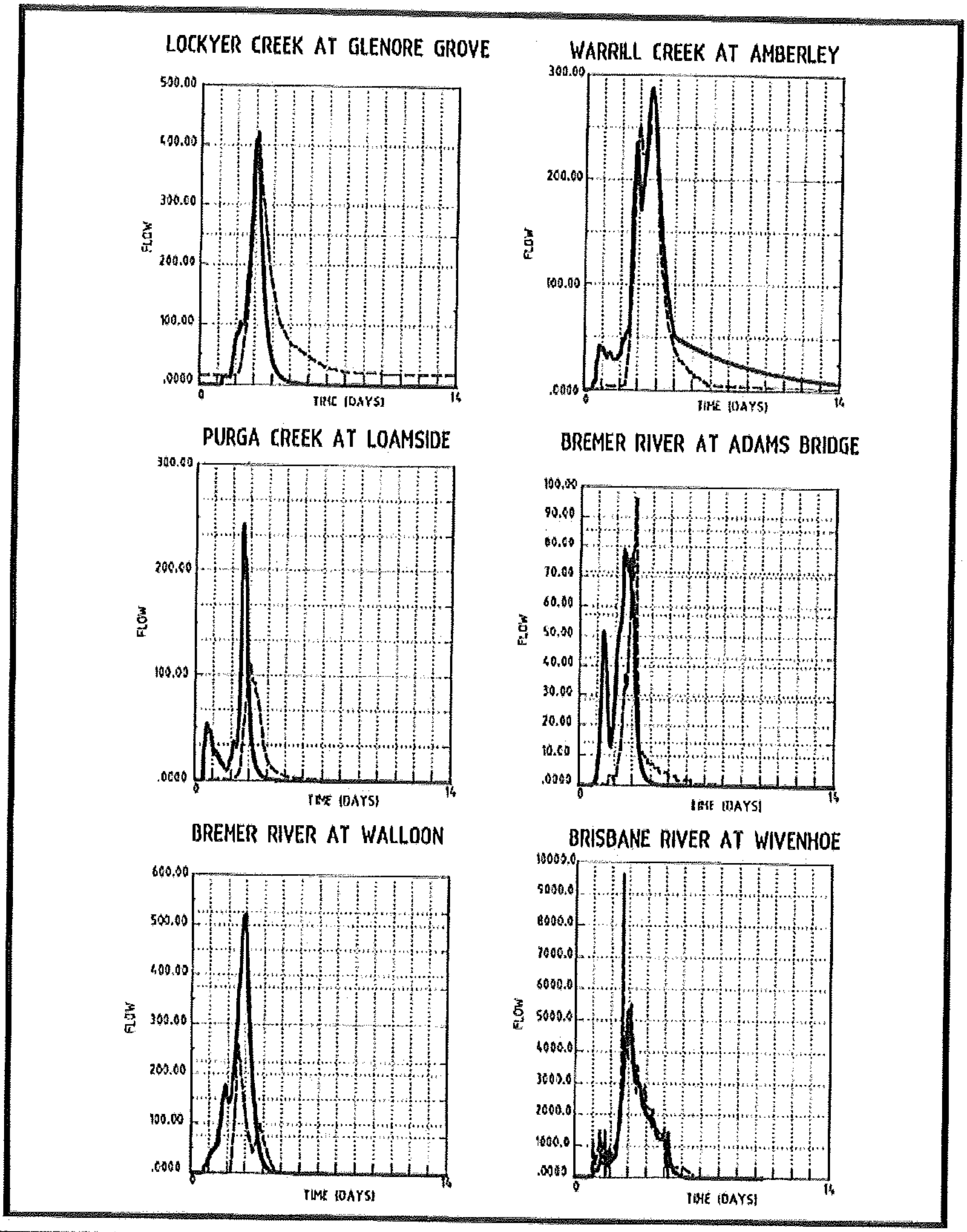
LEGEND

- - - - - RECORDED DISCHARGE

——— PREDICTED DISCHARGE

FILE NAME: 04390-24 DISK Nº: UNFWUD JOB Nº: T004390 DATE: 21-05-99
PLOT SCALE: 1:100

FIGURE C-4c
IPSWICH RIVERS FLOOD STUDY
APRIL 1989 FLOOD HYDROGRAPHS



LEGEND

- - - - - RECORDED DISCHARGE

——— PREDICTED DISCHARGE

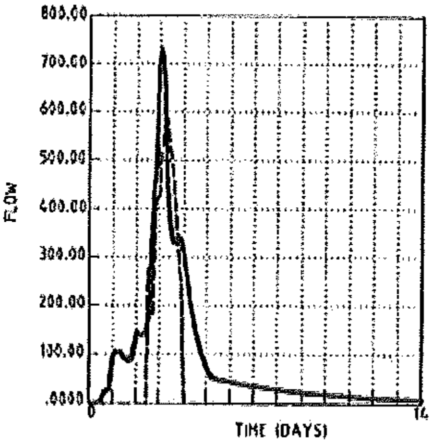
FILE NAME: 04390-24 PLOT SCALE 1:100 DISK N°: LAXFWUD JOB N°: T004390 DATE: 21-05-99

SINCLAIR KNIGHT MERZ

FIGURE C-4d

IPSWICH RIVERS FLOOD STUDY
APRIL 1989 FLOOD HYDROGRAPHS

BREMER RIVER AT DAVID TRUMPY



FILE NAME: 04390-24 DISK N°: UNFWUD JOB N°: TO04390 DATE: 21-05-99
PLOT SCALE: 1:100

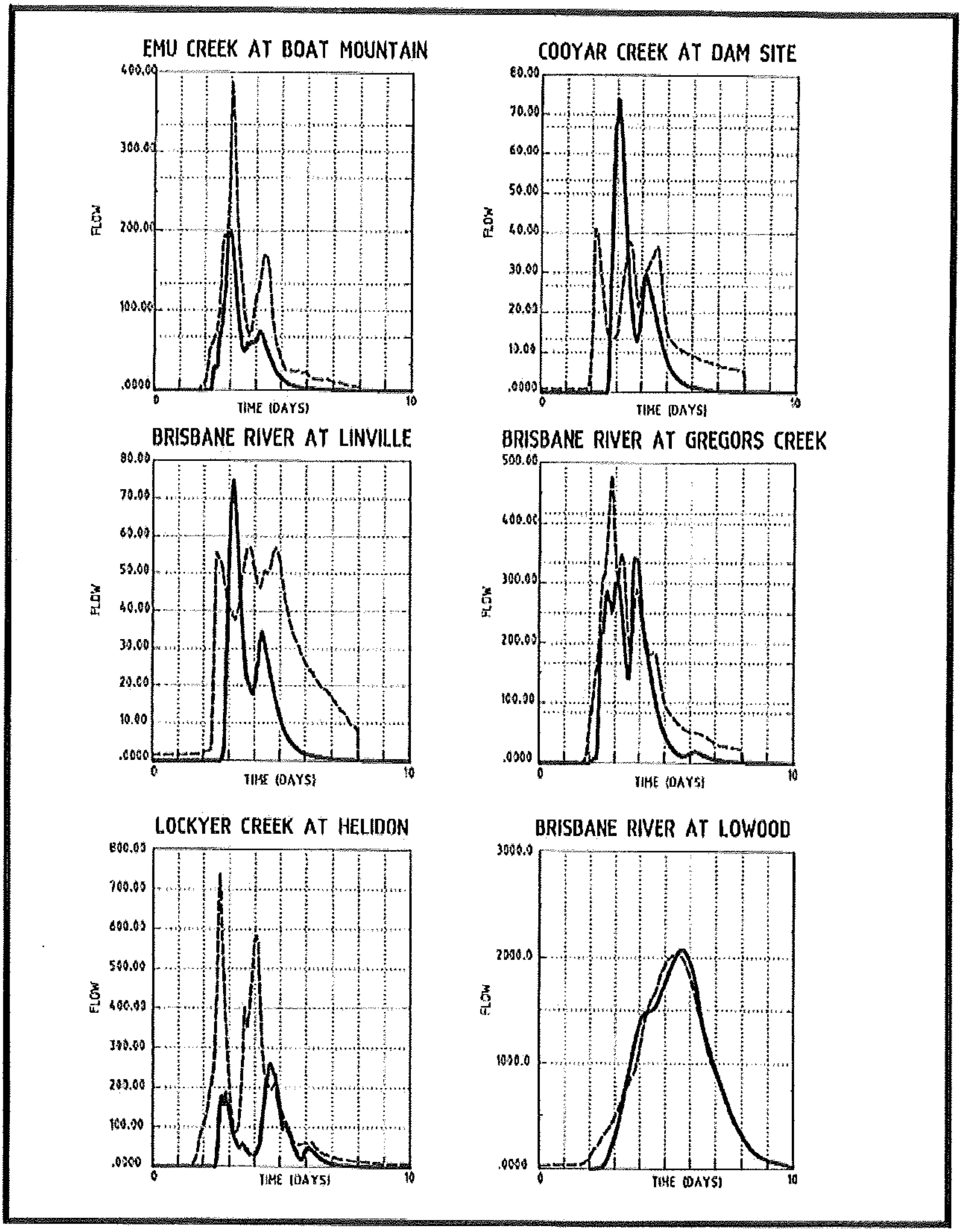
LEGEND

RECORDED DISCHARGE

PREDICTED DISCHARGE

SINCLAIR KNIGHT MERZ

FIGURE C-5a
IPSWICH RIVERS FLOOD STUDY
MAY 1996 FLOOD HYDROGRAPHS



LEGEND

- - - - - - RECORDED DISCHARGE

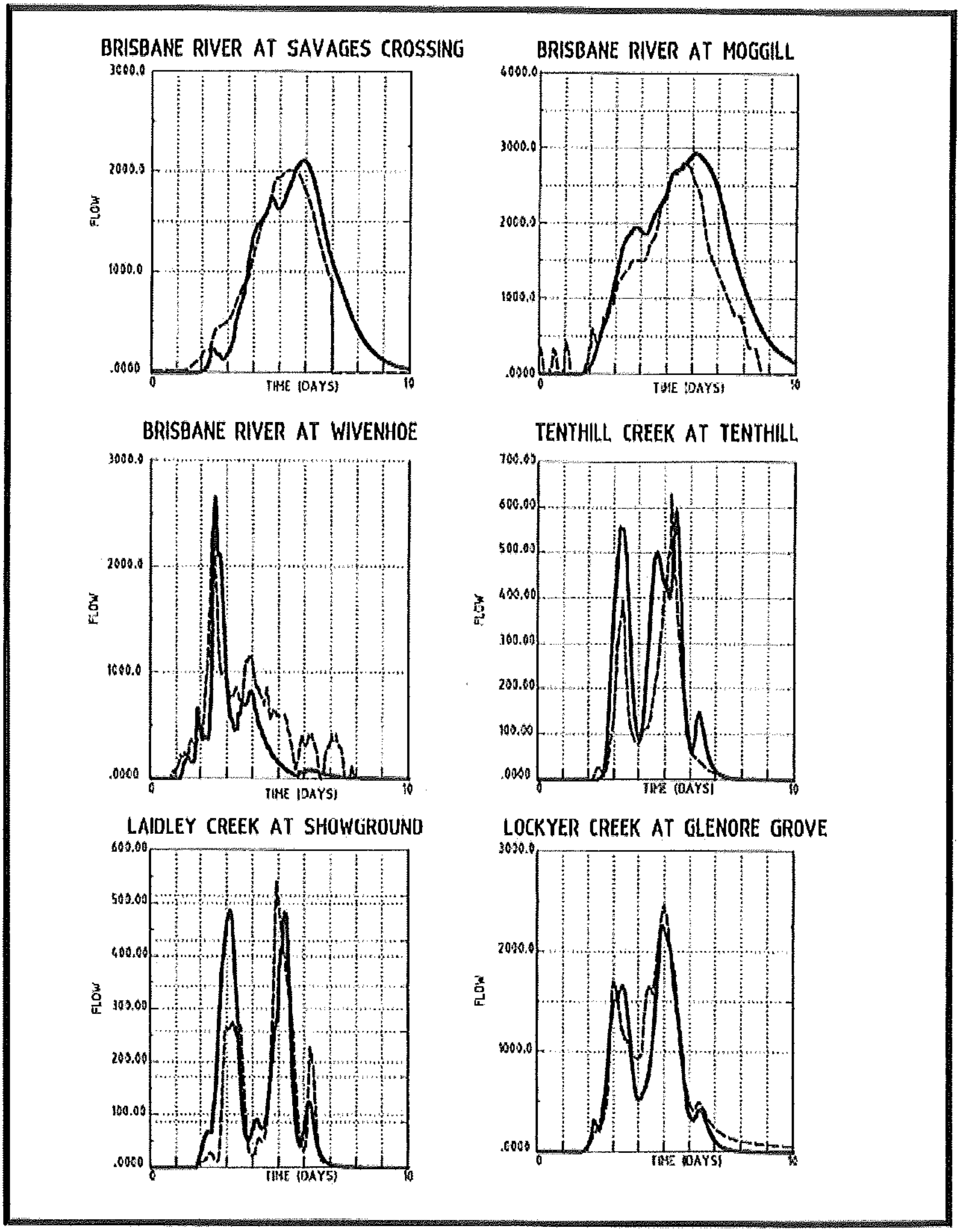
——— PREDICTED DISCHARGE

FILE NAME: 04390-25 DISK N°: UNFWUD JOB N°: T004390 DATE: 21-05-99
PLOT SCALE: 1=100

SINCLAIR KNIGHT MERZ

FIGURE C-5b

IPSWICH RIVERS FLOOD STUDY
MAY 1996 FLOOD HYDROGRAPHS



LEGEND

- - - - - RECORDED DISCHARGE

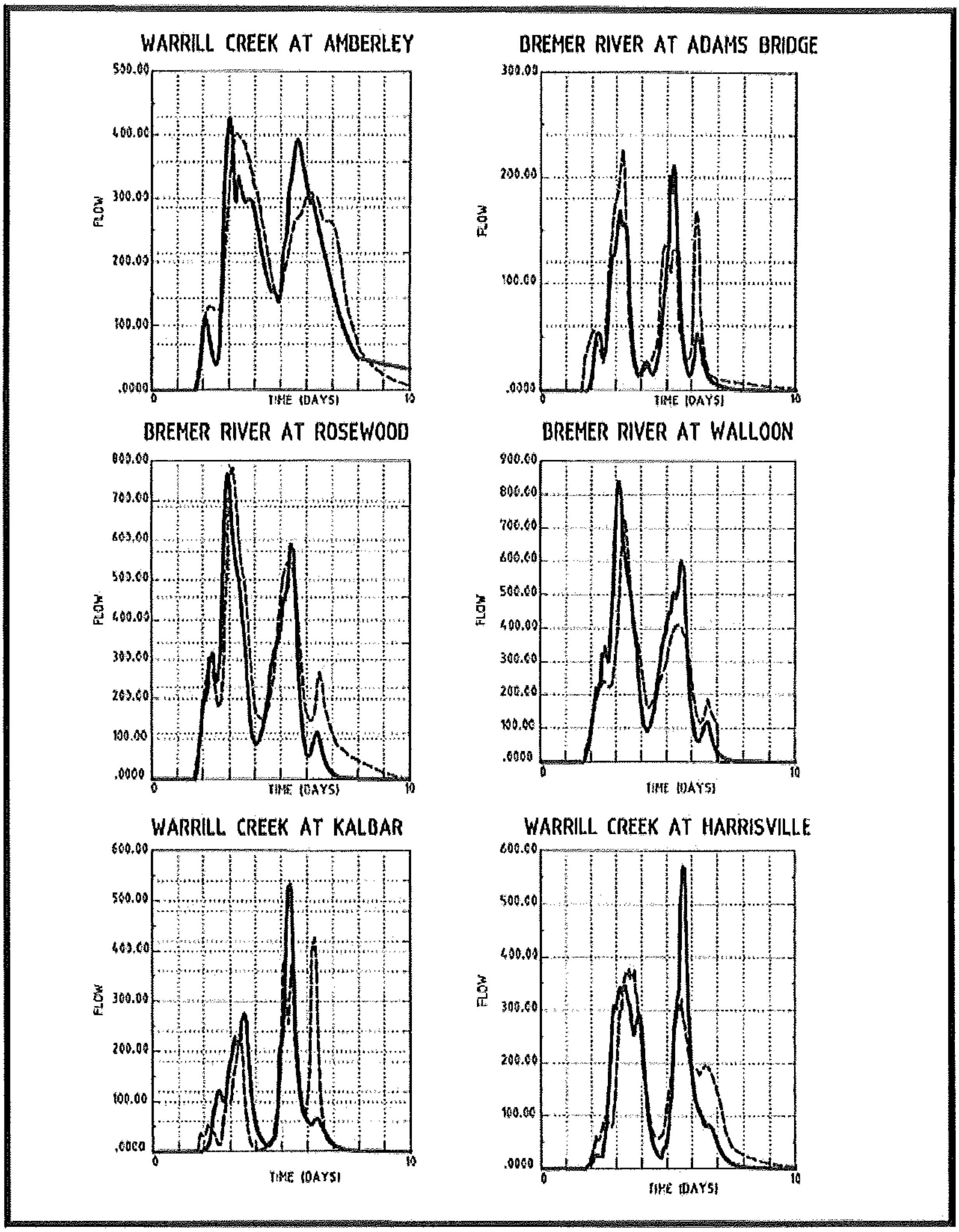
——— PREDICTED DISCHARGE

FILE NAME: 04390-25 PLOT SCALE 1=300 DISK No: U:\NFWUD JOB No: T004390 DATE: 21-05-99

SINCLAIR KNIGHT MERZ

FIGURE C-5c

IPSWICH RIVERS FLOOD STUDY
MAY 1996 FLOOD HYDROGRAPHS



LEGEND

- - - - - - - - RECORDED DISCHARGE

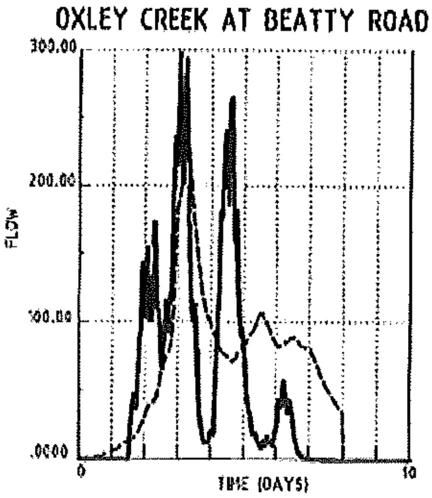
———————— PREDICTED DISCHARGE

FILE NAME: 04390-25 PLOT SCALE: 1=100 DISK N°: UNFAUD JOB N°: TD04390 DATE: 21-05-98

SINCLAIR KNIGHT MERZ

FIGURE C-5d

IPSWICH RIVERS FLOOD STUDY
MAY 1996 FLOOD HYDROGRAPHS



LEGEND

- - - - - - RECORDED DISCHARGE

———— PREDICTED DISCHARGE

FILE NAME: 04390-25 DISK No: UNFWUD JOB No: TC04390 DATE: 21-05-95
PLOT SCALE: 1=100

Appendix D - MIKE11 Model Results Calibration

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	1974 RECORDED WL Left (m AHD)	1974 RECORDED WL Right (m AHD)	1974 DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	1983 RECORDED WL (m AHD)	1983 DIFFERENCE	1989 CALIBRATION EVENT PREDICTED WL (m AHD)	1989 RECORDED WL (m AHD)	1989 DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	1991 RECORDED WL (m AHD)	1991 DIFFERENCE	1996 CALIBRATION EVENT PREDICTED WL (m AHD)	1996 RECORDED WL (m AHD)	1996 DIFFERENCE
BNE	963960		38.56		38.69	-0.13												
BNE	964770		36.45				22.620			21.384						24.924		
BNE	964960		36.07	36.08		-0.01												
BNE	965610		35.26				21.357			19.824						23.302		
BNE	967410		34.55				20.93			19.551						23.197		
BNE	967550		34.43															
BNE	969790		33.93				20.412			19.205						22.583		
BNE	971150		33.30				20.025			18.557						22.137		
BNE	972260		32.78				19.568			18.523						21.731		
BNE	972760		32.71		32.3	0.41												
BNE	973260		32.85	32.49		0.36	19.54			18.396						21.824		
BNE	974580		32.43				20.473			18.54						21.535		
BNE	976020		32.34				19.412			18.253						21.471		
BNE	976810		31.97		32.23	-0.26												
BNE	976980		31.89	32.31		-0.42												
BNE	978280		31.28				17.473			16.338						19.839		
BNE	978500		30.14	30		0.14												
BNE	978573		30.05				15.122			15.204						18.285		
BNE	979530		30.17				15.363			14.969						18.254		
BNE	979860		30.07		30.25	-0.18												
BNE	980330		29.86				15.624			14.469						17.84		
BNE	981060		29.26				15.087			13.925						17.299		
BNE	982480		28.99				14.835			13.751						17.07		
BNE	984100		28.34				14.427			13.313						16.55		
BNE	985260		27.87				13.662			12.87						15.967		
BNE	986400		27.26				13.426			12.37						15.539		
BNE	987800		26.63	26.74		-0.11												
BNE	987950		26.59	26.826		-0.24	12.755			11.764						14.841		
BNE	988150	Mt Crosby	26.33				12.544			11.558	11.4	0.158				14.594		
BNE	988350		26.35				12.275			11.281						14.328		
BNE	989630		25.63		25.55	0.08												
BNE	989702		25.58				11.253			10.712						13.419		
BNE	990120		25.42		25.55	-0.13												
BNE	990185		25.40		25.52	-0.12												
BNE	990450		25.28		25.03	0.25												
BNE	990535		25.25		25.43	-0.18												
BNE	990700		25.19				10.795			9.752						12.984		
BNE	990760		25.13				10.792			9.772						12.949		
BNE	991770		25.00				10.535			9.522						12.727		
BNE	992110		24.93	25.05		-0.12												
BNE	992420		24.88				10.382			9.35						12.514		
BNE	992450		24.82				10.381			9.301						12.539		
BNE	992470		24.79				10.348			9.306						12.545		
BNE	992670		24.71	24.61		0.10	10.254			9.215						12.451		
BNE	992930		24.58		24.58	0.00												
BNE	993190		24.45		24.58	-0.13												
BNE	993760		24.17				9.025			8.617						11.81		
BNE	993900		24.11		24.65	-0.54												
BNE	994180		24.06	24.16		-0.10												
BNE	994760		23.89				8.593			7.960						11.265		
BNE	995135		23.70	24.3		-0.60												
BNE	995290		23.63		23.45	0.18												
BNE	995530		23.51		23.51	0.00												
BNE	995660		23.45	23.02	23.51	0.18												
BNE	995690		23.43				8.587			7.352						10.731		
BNE	995860		23.30															
BNE	996510		23.06		23.45	-0.39												
BNE	996640		23.00															
BNE	996760		22.95		22.96	-0.01												
BNE	996810		22.85				7.45			5.448						9.894		
BNE	997060		22.83		22.99	-0.16												
BNE	997160		22.31															
BNE	997230		22.83															
BNE	997310		22.73		22.72	0.01												

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	1974 RECORDED WL Left (m AHD)	1974 RECORDED WL Right (m AHD)	1974 DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	1983 RECORDED WL (m AHD)	1983 DIFFERENCE	1989 CALIBRATION EVENT PREDICTED WL (m AHD)	1989 RECORDED WL (m AHD)	1989 DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	1991 RECORDED WL (m AHD)	1991 DIFFERENCE	1996 CALIBRATION EVENT PREDICTED WL (m AHD)	1996 RECORDED WL (m AHD)	1996 DIFFERENCE
BNE	997570		22.73		22.53	0.20												
BNE	998450		22.57				6.853			5.815						5.423		
BNE	998560		22.53		22.47	0.06												
BNE	999160		22.29				6.525			5.452						9.134		
BNE	999180		22.25		22.44	-0.16												
BNE	999560		22.16		22.38	-0.22												
BNE	999880		22.08		22.11	-0.05												
BNE	1000000		22.01				6.24			5.201						8.862		
BNE	1000285		21.86		21.92	-0.06	6.2			5.111						8.756		
BNE	1000410		21.79		22.17	-0.38												
BNE	1000775		21.61		21.68	-0.07	6.130			4.965						8.6		
BNE	1001315		21.51		21.5	0.01	6.274			4.789						8.455		
BNE	1001855		21.12		21.1	0.02	5.958			4.51						8.159		
BNE	1002260		20.96				5.875			4.247						7.803		
BNE	1002785		20.95				5.835			4.105						7.801		
BNE	1003275		20.72				5.765			3.898						7.581		
BNE	1003775		20.57		20.91	-0.34	5.71			3.711						7.42		
BNE	1004320		20.23		20.25	-0.02	5.632			3.456						7.176		
BNE	1004812		20.25	20.25	20.25	0.00	5.601			3.394						7.394		
BNE	1005325		20.15				5.555			3.323						6.987		
BNE	1005870		19.96	19.93	19.97	0.01	5.517			3.265						6.845		
BNE	1006250		19.91				5.518			3.257						6.852		
BNE	1006300	Mowett	19.87	19.92		-0.05	5.522	5.2	0.322	3.269	4	-0.731				6.856	7.09	-0.234
BNE	1006910		19.70				5.463			3.22						6.785		
BNE	1007410		19.66		19.33	0.33	5.418			3.167						6.746		
BNE	1007780		19.40				5.329			3.045						6.632		
BNE	1007920		19.35	19.5	19.33	-0.11	5.282			3.06						6.568		
BNE	1008445		19.16	19.40	19.23	-0.15	5.294			3.063						6.585		
BNE	1008925		19.12				5.248			3.021						6.532		
BNE	1009403		19.07				5.212			2.902						6.434		
BNE	1009720		19.03		18.83	0.20	5.192			2.975						6.451		
BNE	1010490		18.78		18.58	0.20	5.088			2.395						6.32		
BNE	1010725		18.82				5.104			2.905						6.344		
BNE	1010880		18.77				5.08			2.837						6.311		
BNE	1011518		18.82	18.63	18.5	0.32	5.053			2.659						6.278		
BNE	1011980		18.75		18.8	-0.01	5.019			2.527						6.236		
BNE	1012425		18.71				4.983			2.794						6.19		
BNE	1012655		18.61		18.6	0.01	4.947			2.764						6.143		
BNE	1013100		18.56				4.932			2.75						6.123		
BNE	1013445		18.51		18.63	-0.12	4.917			2.735						6.104		
BNE	1013680		18.46				4.901			2.717						5.986		
BNE	1013910		18.42				4.879			2.667						6.062		
BNE	1014310		18.34		18.3	0.04	4.842			2.656						6.012		
BNE	1014510	Goodna Hospital	18.29	18.52		-0.23	4.811			2.627						5.975		
BNE	1015200		18.16		18.3	-0.14	4.83			2.644						5.995		
BNE	1015560		17.99	17.96	18.15	-0.16	4.78			2.608						5.529		
BNE	1015850		17.92				4.782			2.593						5.502		
BNE	1016140		17.85	18.15	17.78	-0.31	4.746			2.579						5.84		
BNE	1016440		17.71		17.63	0.08	4.65			2.454						5.702		
BNE	1016890		17.59				4.592			2.431						5.689		
BNE	1017130		17.45		17.54	-0.09	4.522			2.373						5.606		
BNE	1017610		17.32	17.29	17.47	-0.15	4.493			2.344						5.556		
BNE	1017920		17.16				4.444			2.308						5.491		
BNE	1018200		17.08		17.45	-0.37	4.46			2.314						5.517		
BNE	1018725		16.75				4.404			2.286						5.441		
BNE	1019085		16.62		16.83	-0.21	4.379			2.274						5.409		
BNE	1019490		16.52				4.384			2.264						5.386		
BNE	1019803		16.22		16.47	-0.25	4.314			2.245						5.318		
BNE	1020115		16.33	16.56	16.64	-0.31	4.328			2.244						5.345		
BNE	1020525		16.31				4.328			2.24						5.349		
BNE	1020830		16.15		17.02	-0.87	4.2			2.23						5.308		
BNE	1021095		15.94		16.26	-0.32	4.251			2.211						5.24		
BNE	1021539		15.77		16.04	-0.27	4.257			2.154						5.197		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1990 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
			PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BNE	1021715		15.20		15.38	-0.18	4.216			2.191						5.204		
BNE	1021885		15.73		16.74	-1.01	4.209			2.188						5.189		
BNE	1022125		15.62		15.88	-0.26	4.196			2.184						5.169		
BNE	1022575		15.54		15.52	0.02	4.153			2.163						5.115		
BNE	1023040		15.30		15.31	-0.01	4.378			2.138						5.207		
BNE	1023570		15.21		15.31	-0.10	4.343			2.122						4.952		
BNE	1024083		15.17		15.13	0.03	3.994			2.1						4.921		
BNE	1024563		15.10		15.4	-0.30	3.946			2.077						4.841		
BNE	1025070		15.02		15.19	-0.17	3.915			2.061						4.798		
BNE	1025360		14.88				3.873			2.047						4.74		
BNE	1025590		14.71		14.94	-0.23	3.828			2.031						4.675		
BNE	1026170		14.56		14.64	-0.06	3.795			2.016						4.635		
BNE	1026480		14.40	14.55	14.47	-0.07	3.755			2						4.502		
BNE	1026900		14.36	14.24	14.55	-0.03	3.729			1.942						4.543		
BNE	1027350		14.23	14.24	14.38	-0.12	3.703			1.936						4.514		
BNE	1027680		14.20		14.32	-0.03	3.683			1.973						4.468		
BNE	1028180		14.22	14.12	14.3	0.11	3.652			1.955						4.445		
BNE	1028680		14.20				3.577			1.931						4.34		
BNE	1028720		14.17															
BNE	1028765		14.14				3.509			1.911						4.232		
BNE	1029200		14.00		14.09	-0.09	3.443			1.89						4.137		
BNE	1029680		14.00		13.97	0.05	3.424			1.884						4.111		
BNE	1030220		14.04		13.63	0.41	3.383			1.871						4.056		
BNE	1030870		13.98				3.318			1.849						3.965		
BNE	1031290		13.93	13.51	13.73	0.20	3.257			1.831						3.878		
BNE	1031700		13.66	13.26	13.79	-0.13	3.179			1.81						3.728		
BNE	1031995		13.52				3.103			1.809						3.759		
BNE	1032230		13.41		13.18	0.23	3.167			1.804						3.745		
BNE	1032565		13.17	12.9	13.12	0.05	3.154			1.795						3.695		
BNE	1033080		13.02		12.99	0.03	3.104			1.787						3.651		
BNE	1033370		12.92	12.9	12.93	-0.01	3.072			1.777						3.632		
BNE	1033800		12.70	12.57	12.71	-0.01	3.013			1.761						3.513		
BNE	1034370		12.54		12.26	0.28	2.967			1.748						3.443		
BNE	1034880		12.46		12.52	-0.06	2.934			1.739						3.393		
BNE	1035414		12.22		12.14	0.08	2.879			1.723						3.31		
BNE	1035900		11.93		11.87	0.06	2.820			1.708						3.225		
BNE	1036450		11.65	11.74	11.77	-0.11	2.775			1.695						3.159		
BNE	1036770		11.56	11.24	11.39	0.17	2.749			1.686						3.115		
BNE	1036915		11.43	11.32	11.47	-0.04	2.739			1.684						3.095		
BNE	1037090		11.30	11.2	11.44	-0.14	2.743			1.685						3.103		
BNE	1037110		11.29															
BNE	1037175		11.18	11.13	11.47	-0.29	2.646			1.66						2.96		
BNE	1037285		10.93		11.2	-0.27	2.625			1.654						2.925		
BNE	1037625		10.93	11.07	11.1	-0.18	2.605			1.645						2.890		
BNE	1038085		10.96		11.1	-0.14	2.589			1.643						2.874		
BNE	1038500		10.94		11.04	-0.10	2.535			1.629						2.793		
BNE	1039100		10.91		11.07	-0.16	2.484			1.613						2.715		
BNE	1039200		10.91				2.477			1.611						2.735		
BNE	1039565		10.90		11.01	-0.11	2.455			1.604						2.672		
BNE	1039670		10.89				2.453			1.603						2.659		
BNE	1039928		10.88				2.45			1.603						2.663		
BNE	1040090		10.86		11.04	-0.18	2.444			1.601						2.657		
BNE	1040250		10.81				2.426			1.597						2.635		
BNE	1040490		10.72		11.01	-0.28	2.397			1.59						2.589		
BNE	1041010		10.77		10.89	-0.12	2.387			1.586						2.58		
BNE	1041230		10.73		10.83	-0.10	2.373			1.582						2.556		
BNE	1041460		10.64		10.83	-0.19	2.353			1.576						2.523		
BNE	1041700		10.61		10.83	-0.22	2.353			1.576						2.522		
BNE	1041960		10.47		10.82	-0.35	2.315			1.566						2.48		
BNE	1042235		10.31		10.42	-0.11	2.285			1.550						2.413		
BNE	1042500		10.31				2.277			1.554						2.403		
BNE	1042515		10.31		10.43	-0.12	2.276			1.554						2.403		
BNE	1042935		10.25	10.16	10.21	0.04	2.225			1.54						2.329		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BNE	1043010		10.21				2.21			1.526						2.207		
BNE	1043080		10.18				2.199			1.533						2.231		
BNE	1043110		10.17				2.195			1.532						2.205		
BNE	1043725		9.93		9.95	-0.02	2.13			1.515						2.192		
BNE	1044060		9.77		9.81	-0.04	2.108			1.509						2.161		
BNE	1044340		9.61		9.61	0.00	2.073			1.502						2.117		
BNE	1044625		9.56		9.49	0.07	2.063			1.498						2.097		
BNE	1044950		9.52		9.55	-0.03	2.05			1.494						2.075		
BNE	1045400		9.54		9.51	0.03	2.007			1.488						2.009		
BNE	1045885		9.14	9.15	9.46	-0.17	1.958			1.477						1.954		
BNE	1046130		9.08		9.48	-0.42	1.902			1.470						1.939		
BNE	1046340		9.01		9.57	-0.55	1.558			1.475						1.933		
BNE	1046580		8.56				1.95			1.473						1.921		
BNE	1046930		8.77		9.03	-0.20	1.917			1.467						1.871		
BNE	1047350		8.38	8.35	8.57	-0.17	1.876			1.46						1.904		
BNE	1047915		8.35		8.36	-0.21	1.855			1.455						1.774		
BNE	1048375		8.22	8.36	8.3	-0.11	1.834			1.452						1.778		
BNE	1048830		7.98		8.09	-0.11	1.792			1.444						1.765		
BNE	1049120		7.93	8.27	8.24	-0.33	1.784			1.441						1.733		
BNE	1049373		7.74				1.754			1.437						1.73		
BNE	1049503		7.72				1.751			1.436						1.728		
BNE	1049870		7.51	7.57	7.9	-0.13	1.732			1.432						1.725		
BNE	1050490		7.57		7.75	-0.18	1.712			1.428						1.72		
BNE	1050860		7.44	7.57	7.49	-0.05	1.587			1.424						1.715		
BNE	1051380		7.45				1.901			1.421						1.711		
BNE	1051865		7.25	7.14	7.20	0.05	1.540			1.415						1.703		
BNE	1052310		7.38	7.08	7.17	0.25	1.053			1.415						1.7		
BNE	1052370		7.23															
BNE	1052390		7.18		7.23	-0.05	1.637			1.403						1.694		
BNE	1052505		7.00				1.63			1.403						1.691		
BNE	1052607		6.91															
BNE	1052640		6.43	6.35	7.05	-0.27	1.597			1.403						1.586		
BNE	1052865		6.31		6.56	-0.25	1.59			1.401						1.583		
BNE	1053020		6.26		6.44	-0.18	1.59			1.397						1.579		
BNE	1053256		6.15															
BNE	1053385		6.05		6.44	-0.38	1.549			1.396						1.672		
BNE	1053920		5.66		6.04	-0.38	1.528			1.392						1.658		
BNE	1054640		5.58				1.529			1.387						1.665		
BNE	1054650		5.54															
BNE	1054680		5.50	6.25	5.77	-0.52	1.515			1.387						1.66		
BNE	1054870		5.24		5.59	-0.36	1.487			1.385						1.657		
BNE	1055280		5.19				1.476			1.383						1.655		
BNE	1055420		5.17		5.44	-0.27	1.468			1.382						1.654		
BNE	1055960		5.33	4.95	5.44	-0.05	1.440			1.378						1.65		
BNE	1056400		4.88	5.31	5.31	-0.43	1.407			1.374						1.645		
BNE	1056605		4.82				1.403			1.371						1.642		
BNE	1056655		5.04	4.76	5.4	-0.04	1.410			1.371						1.643		
BNE	1056920		4.96															
BNE	1056950		4.92	4.8	5.47	-0.21	1.406			1.372						1.635		
BNE	1057093		4.76	4.8	5.28	-0.28	1.399			1.371						1.637		
BNE	1057530		4.63		4.86	-0.23	1.385			1.368						1.633		
BNE	1058043		4.37	4.21	4.4	0.05	1.351			1.363						1.629		
BNE	1058230		4.28				1.344			1.367						1.625		
BNE	1058530		4.15	4.49	4.79	-0.48	1.344			1.358						1.624		
BNE	1058725		4.15	4.22	4.58	-0.22	1.345			1.355						1.623		
BNE	1059035		3.92	3.25	4.20	-0.04	1.364			1.352						1.621		
BNE	1059540		3.87	3.51	4.00	-0.13	1.358			1.347						1.618		
BNE	1059930		3.62	3.48	4	-0.08	1.355			1.343						1.616		
BNE	1060245		3.39		3.27	0.12	1.357			1.339						1.613		
BNE	1060535		3.35	3.21	3.33	-0.02	1.357			1.337						1.612		
BNE	1061015		3.21		3.78	0.23	1.372			1.332						1.61		
BNE	1061530		2.99				1.375			1.325						1.506		
BNE	1062020		2.83	3.05	3.13	-0.18	1.271			1.32						1.500		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BNE	1062535		2.89	2.5	3.15	0.02	1.38			1.315						1.5		
BNE	1062945		2.89				1.38			1.311						1.598		
BNE	1063125		2.34				1.379			1.31						1.597		
BNE	1063310		2.75	2.6	3.3	-0.19	1.377			1.305						1.597		
BNE	1063845		2.48	2.62	2.63	-0.15	1.358			1.304						1.594		
BNE	1064090		2.45		2.78	-0.34	1.362			1.3						1.593		
BNE	1064410		2.33	2.35	2.42	-0.08	1.352			1.294						1.59		
BNE	1065070		2.36		2.48	-0.12	1.345			1.288						1.588		
BNE	1065503		2.33		2.51	-0.18	1.338			1.283						1.586		
BNE	1065990		2.36		2.49	-0.13	1.334			1.279						1.584		
BNE	1066505		2.28		2.51	-0.23	1.335			1.275						1.582		
BNE	1067020		2.28	2.42	2.56	-0.14	1.333			1.271						1.58		
BNE	1067485		2.15	2.42	2.58	-0.24	1.320			1.268						1.578		
BNE	1067965		2.05		2.02	0.03	1.318			1.263						1.574		
BNE	1068550		1.89		2.02	-0.13	1.303			1.255						1.568		
BNE	1069045		1.83		1.9	-0.07	1.298			1.252						1.564		
BNE	1069535		1.79		1.9	-0.11	1.289			1.248						1.559		
BNE	1070025		1.74		1.85	-0.11	1.283			1.245						1.555		
BNE	1070530		1.65				1.277			1.242						1.551		
BNE	1071045		1.64				1.276			1.239						1.549		
BNE	1071520		1.64				1.282			1.237						1.547		
BNE	1072013		1.63				1.278			1.235						1.544		
BNE	1072020		1.63				1.278			1.235						1.544		
BNE	1072515		1.62				1.282			1.233						1.541		
BNE	1072985		1.61				1.282			1.227						1.538		
BNE	1073185		1.61				1.274			1.228						1.534		
BNE	1074020		1.60				1.265			1.235						1.529		
BNE	1074480		1.60				1.253			1.238						1.523		
BNE	1074985		1.60				1.221			1.238						1.519		
BNE	1075480		1.59				1.245			1.238						1.518		
BNE	1075900		1.58				1.258			1.236						1.516		
BNE	1076495		1.58				1.256			1.225						1.515		
BNE	1077010		1.57				1.257			1.217						1.514		
BNE	1077510		1.57				1.271			1.207						1.512		
BNE	1078040		1.55				1.271			1.202						1.511		
BNE	1078575		1.56				1.254			1.2						1.51		
BNE	1078992		1.56		1.55	0.00	1.27			1.2						1.51		
BREM	1000000		27.17				18.503			15.544						69.349		
BREM	1000110		27.11	26.6		0.51												
BREM	1000210		27.06	26.7		0.35												
BREM	1000310		27.06	26.7		0.36												
BREM	1000560		26.88	24		2.88												
BREM	1000700		26.82				18.137			15.209						18.979		
BREM	1000740		26.81	26		0.81												
BREM	1000800		26.81	26		0.81												
BREM	1001120		26.71				17.885			14.924						18.847		
BREM	1001700		26.49				17.675			14.353						18.556		
BREM	1002300		26.49				17.307			13.877						18.318		
BREM	1002400		26.01		26.5	-0.49												
BREM	1002450		25.85		26	-0.15												
BREM	1002700		25.59				17.318			13.518						17.894		
BREM	1003070		25.29		25.4	-0.11												
BREM	1003130	Parry St	25.29				16.738			13.152						17.556	16.75	0.805
BREM	1003250		25.18				16.077			13.127						17.53		
BREM	1003350		25.18															
BREM	1003350		25.11	25.4		-0.29												
BREM	1003435		25.11	25.4		-0.29												
BREM	1003570		25.04	25.2		-0.16												
BREM	1003600		25.02	25.1		-0.08												
BREM	1003700		24.98				15.431			12.652						17.292		
BREM	1003750		24.97	25.2		-0.23												
BREM	1003900		24.97	25.2		-0.23												
BREM	1003950		24.90	24.9		0.03												

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1988 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BREM	1004050		24.90	24.8		0.05												
BREM	1004100		24.90	25		-0.10												
BREM	1004150		24.80				16.234			12.221						17.093		
BREM	1004300		24.89															
BREM	1004400		24.85	25.1		-0.25												
BREM	1004500		24.79	25.1		-0.31												
BREM	1004590	One Mile Bridge	24.76				15.905	14.82	1.085	11.971	12.15	-0.179				16.765	16.75	0.015
BREM	1004600		24.75		25.2	-0.45												
BREM	1004610		24.74				15.455			11.528						16.495		
BREM	1004700		24.51				15.511			11.845						16.521		
BREM	1005140		24.82				15.277			11.629						16.288		
BREM	1005150		24.62															
BREM	1005470		24.26		24.5	-0.24												
BREM	1005500		24.23		25.1	-0.87												
BREM	1005520		24.23				15.005			11.421						15.996		
BREM	1005550		24.23															
BREM	1005600		24.23	24.1	24.1	0.13												
BREM	1005740		24.27				14.963			11.349						15.967		
BREM	1005800		24.27															
BREM	1005900		24.10		24.5	-0.31												
BREM	1006000		23.96	25.2		-1.25												
BREM	1006040		23.84				14.52			11.305						15.503		
BREM	1006250		23.92				14.607			11.023						15.612		
BREM	1006470		23.73	23.9		-0.17												
BREM	1006490		23.72				14.343			10.789						15.329		
BREM	1006510		23.65				14.275			10.734						15.268		
BREM	1006520		23.65															
BREM	1006770		23.65		23.8	-0.15												
BREM	1006780		23.62				14.152			10.525						15.172		
BREM	1006900		23.62															
BREM	1007100		23.35	23.5		-0.15												
BREM	1007400		23.35	23.5		-0.15												
BREM	1007440		23.06				13.381			9.736						14.471		
BREM	1007500		23.06		23.2	-0.14												
BREM	1007730		23.09	23.2		-0.11	13.283			9.615						14.331		
BREM	1007920		23.09	23.2		-0.11												
BREM	1008000		22.78	22.8	23	-0.12	13.035			9.419						14.101		
BREM	1008140		22.78	22.8	23	-0.12												
BREM	1008240		22.63		23.1	-0.47												
BREM	1008280		22.69		23.1	-0.41												
BREM	1008320		22.66	22.6		0.06												
BREM	1008390	Hancock Bridge	22.53				12.743			9.397						13.826	14.2	-0.374
BREM	1008410		22.54				12.692			9.357						13.747		
BREM	1008420		22.54			-	12.666			9.055						13.706		
BREM	1008580		22.40		22.5	-0.10												
BREM	1008630		22.40		22.5	-0.10												
BREM	1008680		22.24				12.358			8.826						13.427		
BREM	1008720		22.39		22.8	-0.41												
BREM	1008800		22.19		22.6	-0.41												
BREM	1009200		21.83	22.2		-0.37												
BREM	1009270		21.82				12.015			8.514						13.056		
BREM	1009390		21.82															
BREM	1009410		21.74	22.2		-0.43												
BREM	1009600		21.65	22		-0.35												
BREM	1009670		21.65	22		-0.35												
BREM	1009675		21.52				11.863			8.393						12.905		
BREM	1010020		21.36				11.554			8.148						12.581		
BREM	1010270		21.36															
BREM	1010280		21.30				11.472			8.084						12.574		
BREM	1010350		21.27		21.8	-0.53												
BREM	1010400		21.27		21.8	-0.53												
BREM	1010430		21.23	21.2	21.1	0.08												
BREM	1010700		21.14				11.289			7.933						12.332		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1963 CALIBRATION EVENT			1959 CALIBRATION EVENT			1931 CALIBRATION EVENT			1925 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BREM	1010700		21.14															
BREM	1010850		21.02				11.131			7.839						12.158		
BREM	1010900		21.02															
BREM	1010920		21.02		21.2	-0.18												
BREM	1011020		21.02		21.1	-0.08												
BREM	1011320		20.94				10.917			7.591						11.872		
BREM	1011400		20.94															
BREM	1011500		20.85		20.7	0.15												
BREM	1011700		20.77		21	-0.23	10.563			7.325						11.605		
BREM	1011790		20.73				10.512			7.271						11.55		
BREM	1011810		20.62				10.462			7.24						11.505		
BREM	1011820		20.62		21.2	-0.58												
BREM	1012050		20.61				10.457			7.215						11.500		
BREM	1012070	Marsden Pde/ David Tramway	20.60	20.7		-0.10	10.333	10.6	-0.267	7.125	7.3	-0.175				11.382	11.31	0.072
BREM	1012100		20.59		20.7	-0.11												
BREM	1012200		20.57		20.7	-0.13	10.226			7.092						11.276		
BREM	1012300		20.57		20.7	-0.13												
BREM	1012400		20.57		20.7	-0.13												
BREM	1012450		20.57		20.7	-0.13												
BREM	1012730		20.56		20.6	-0.04												
BREM	1012970		20.56	20.7		-0.14	10.234			7.033						11.282		
BREM	1013000		20.56	20.6	21.3	-0.39												
BREM	1013020		20.56	20.6	21.3	-0.39												
BREM	1013380		20.55	20.6	20.8	-0.15	10.117			6.947						11.161		
BREM	1013400		20.55	20.6	20.8	-0.15												
BREM	1013650		20.55	20.6		-0.05												
BREM	1013700		20.54				10.085			6.896						11.134		
BREM	1013750		20.54															
BREM	1013800		20.54	20.7	20.5	-0.06												
BREM	1013940		20.52	20.8		-0.28												
BREM	1014150		20.52	20.8		-0.28												
BREM	1014210		20.50	20.8	20.6	-0.10												
BREM	1014220		20.50				9.928			6.773						10.942		
BREM	1014300		20.50															
BREM	1014480		20.49	20.4		0.09												
BREM	1014640		20.48	20.5	20.4	0.01	9.841			6.722						10.868		
BREM	1014600		20.46	20.5	20.4	0.01												
BREM	1014700		20.46		20.4	0.03												
BREM	1015180		20.46		20.4	0.06	9.684			6.612						10.697		
BREM	1015200		20.43		20.6	-0.17												
BREM	1015220		20.44		20.6	-0.16												
BREM	1015400		20.44		20.6	-0.15												
BREM	1015445		20.44				9.683			6.584						10.703		
BREM	1015640		20.44			-												
BREM	1015710		20.44				9.673			6.568						10.703		
BREM	1015800		20.44															
BREM	1015900		20.44		20.6	-0.16												
BREM	1016000		20.44		20.4	0.04												
BREM	1016050		20.44		20.4	0.04												
BREM	1016100		20.43		20.4	0.03												
BREM	1016110		20.43				9.534			6.521						10.63		
BREM	1016200		20.42		20.5	-0.07												
BREM	1016250		20.43		20.4	0.03												
BREM	1016450		20.43		20.4	0.03												
BREM	1016570		20.43		20.6	-0.18	9.523			6.475						10.545		
BREM	1016620		20.42		20.4	0.02												
BREM	1017200		20.41		20.5	-0.05												
BREM	1017300		20.40				9.455			6.417						10.458		
BREM	1017750		20.40				9.391			6.357						10.405		
BREM	1018140		20.39				9.335			6.275						10.312		
BREM	1018320		20.39				9.281			6.268						10.283		
BREM	1018500		20.38				9.261			6.262						10.256		
BREM	1018630		20.39				9.228			6.235						10.205		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				2003 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BREM	1018700		20.39	20.6		-0.21												
BREM	1018780		20.39				8.353			6.199						10.139		
BREM	1019030		20.39	20.4		-0.01												
BREM	1019150		20.39				8.179			6.186						10.161		
BREM	1019302		20.39															
BREM	1019580		20.38				9.003			6.116						10.044		
BREM	1019830		20.38	21.5		-1.12												
BREM	1019900		20.38	21.5		-1.12												
BREM	1019905		20.37	20.4		-0.03												
BREM	1019910		20.37	20.8		-0.43												
BREM	1020000		20.37				8.954			6.019						9.32		
BREM	1020350		20.36				8.958			5.982						9.331		
BREM	1020450		20.36				8.949			5.959						9.324		
BREM	1020920		20.35				8.729			5.745						9.178		
BREM	1021450		20.34				8.499			5.551						8.451		
BREM	1022300		20.32				8.092			5.214						8.648		
BREM	1022550		20.31				7.923			5.099						8.868		
BREM	1023000		20.30		20.6	-0.30												
BREM	1023400		20.28				7.656			4.815						8.565		
BREM	1023510		20.24				7.457			4.672						8.315		
BREM	1023870		20.23				7.357			4.596						8.229		
BREM	1024220		20.21				7.183			4.449						7.908		
BREM	1024500		20.20		20.4	-0.20												
BREM	1024520		20.20				7.052			4.346						7.678		
BREM	1024750		20.18				6.998			4.307						7.612		
BREM	1025300		20.15				6.850			4.205						7.534		
BREM	1025070		20.12				6.68			4.072						7.421		
BREM	1025920		20.11				6.570			4.007						7.275		
BREM	1026110		20.11															
BREM	1026150		20.09				6.527			3.954						7.224		
BREM	1026560		20.07				6.352			3.854						7.151		
BREM	1027100		20.04				6.128			3.833						7.067		
BREM	1027380		20.02		19.5	0.52												
BREM	1027500		20.01		20.7	-0.69												
BREM	1027640		19.99				5.927			3.565						6.312		
BREM	1027700		19.99		20.7	-0.71												
BREM	1027800		19.98		20.4	-0.42												
BREM	1027840		19.98				5.839			3.501						6.959		
BREM	1027900		19.98		20.5	-0.52												
BREM	1028150		19.95				5.626			3.353						6.673		
BREM	1028400		19.91	20.25	19.97	-0.70	5.519			3.267						5.852		
OXLEY	599400		10.882				2.455			1.605						2.664		
OXLEY	600000		10.802				2.45			1.603						2.665		
BREAKFAST	599400		4.111			-	3.154			2.632						3.541		
BREAKFAST	600000		2.847				3.379			1.31						1.547		
BULIMBA	599400		1.633				1.327			1.227						1.553		
BULIMBA	600000		1.63				1.278			1.235						1.544		
GOODNALINK1	0		18.559				4.502			2.75						6.123		
GOODNALINK1	1000		17.502				4.503			2.431						5.889		
GOODNALINK2	0		18.464				4.901			2.717						6.066		
GOODNALINK2	1070		17.916				4.762			2.593						5.902		
STLUCIALINK1	0		10.911				2.477			1.811						2.765		
STLUCIALINK1	1000		10.188				2.195			1.532						2.285		
STLUCIALINK2	0		10.883				2.453			1.920						2.609		
STLUCIALINK2	1050		10.235				2.21			1.536						2.307		
STLUCIALINK3	0		10.814				2.429			1.587						2.535		
STLUCIALINK3	850		10.312				2.277			1.554						2.402		
SIX	9630		47.55				47.188			47.034						47.334		
SIX	9795		44.55				43.544			43.402						43.771		
SIX	10060		40.95				40.004			39.703						40.343		
SIX	10310		39.05				37.953			37.279						38.301		
SIX	10365		38.92				37.82			37.534						38.276		
SIX	10380		38.85				37.647			37.381						38.578		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1988 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1990 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
SX	10480		28.62				37.409			37.333						37.852		
SX	10920		37.21				36.201			35.951						36.507		
SX	11255		34.75				33.906			33.861						34.175		
SX	11570		33.30				32.567			32.355						32.781		
SX	11670		32.50				32.314			31.922						32.532		
SX	11770		32.80				32.703			31.83						32.499		
SX	11800		32.22				31.76			31.573						31.857		
SX	11870		32.16				31.578			31.506						31.753		
SX	12030		31.53				30.392			30.832						30.964		
SX	12470		29.48				29.032			28.845						29.189		
SX	12970		27.35				26.907			26.807						27.036		
SX	13295		26.32				25.037			25.545						25.77		
SX	13620		25.23				24.813			24.521						24.815		
SX	14045		23.27				22.887			22.925						22.935		
SX	14470		22.07				21.163			20.990						21.489		
SX	14800		21.63				20.641			20.468						20.987		
SX	15170		20.66				19.067			18.882						19.227		
SX	15570		20.57				18.913			18.795						19.455		
SX	15810		20.49				18.944			18.782						19.41		
SX	16270		20.25				18.624			18.658						19.283		
SX	16470		19.48				18.041			17.881						18.461		
SX	16720		19.48				15.921			15.851						16.104		
SX	17140		19.48				12.801			12.902						13.258		
SX	17270		19.48				12.524			12.226						13.081		
SX	17530		19.48				11.707			11.513						12.266		
SX	17630		19.48				10.706			10.505						11.414		
SX	17970		19.48	20.3		-0.82												
SX	18020		19.48	19.7		-0.22												
SX	18270		19.48				9.577			9.424						9.878		
SX	18720		19.48				8.624			5.335						7.382		
SX	18970		19.48	20.1		-0.62	5.408			5.043						6.636		
SX	19170		19.48				5.34			4.37						6.636		
SX	19370		19.48				5.337			3.641						6.636		
SX	19530		19.48	20.5	20.8	-1.17	5.336			3.102						6.636		
SX	19790		19.48				5.336			3.102						6.636		
SX	19873		19.48	20		-0.52	5.333			3.098						6.634		
SX	20003		19.48	19.97		-0.49	5.332			3.098						6.634		
SX	20140		19.48				5.332			3.098						6.634		
SX	20160		19.48				5.329			3.058						6.632		
SX	20235		19.48				5.329			3.065						6.632		
GOOD	10000		22.82				22.192			21.721						22.29		
GOOD	10275		21.27				20.556			19.99						20.875		
GOOD	10475		20.42				19.38			19.57						20.063		
GOOD	10705		19.21			-	18.775			18.228						18.837		
GOOD	10925		18.71				17.154			16.498						17.31		
GOOD	11335		18.71				15.453			14.829						15.597		
GOOD	11625		18.71				14.509			14.26						15.009		
GOOD	11945		18.71	18.6	18.6	0.11	14.107			13.192						14.497		
GOOD	11965		18.71		18.86	-0.15												
GOOD	12044		18.71				13.503			12.98						13.832		
GOOD	12155		18.71				13.305			12.826						13.419		
GOOD	12425		18.71				12.505			12.146						12.684		
GOOD	12685		18.71				11.882			11.471						11.945		
GOOD	12935		18.71				11.560			11.212						11.847		
GOOD	12945		18.71	18.1		0.61												
GOOD	13275		18.71				11.234			10.571						11.33		
GOOD	13235		18.71	18.7		0.01												
GOOD	13445		18.71	18.8		-0.09												
GOOD	13475		18.71				10.837			10.232						11.029		
GOOD	13545		18.71	18.6		0.11												
GOOD	13645		18.71	18.9		-0.19												
GOOD	13875		18.71				10.532			10.271						10.6		
GOOD	13895		18.71	19.3		-0.59												

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1998 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
GOOD	13745		18.71	18.9		-0.19												
GOOD	13945		18.71	19.3		-0.59												
GOOD	14045		18.71	18.6		0.11												
GOOD	14155		18.71				7.450			6.875						7.719		
GOOD	14195		18.71				7.399			6.581						7.682		
GOOD	14265		18.71				7.288			6.452						7.564		
GOOD	14375		18.71				7.248			6.399						7.534		
GOOD	14385		18.71	18.6	18.7	0.11												
GOOD	14555		18.71				7.133			8.222						7.435		
GOOD	14575		18.71				7.128			8.213						7.433		
GOOD	14615		18.71				5.402			5.64						6.318		
GOOD	14635		18.71				5.264			5.743						6.772		
GOOD	14695		18.71	18.6		0.11												
GOOD	14735		18.71				6.022			5.093						6.092		
GOOD	14795		18.71	18.5		0.21												
GOOD	14835		18.71				5.022			4.614						8.652		
GOOD	14905		18.71				5.010			4.613						8.651		
GOOD	14920		18.71				5.022			4.566						8.191		
GOOD	14930		18.71				5.281			4.481						8.191		
GOOD	14975		18.71				5.24			4.446						8.191		
GOOD	15245		18.71		18	0.71												
GOOD	15350		18.71				4.566			3.096						8.19		
GOOD	15845		18.71	18.5		0.21	4.954			3.058						8.19		
GOOD	15945		18.71	18.4		0.31												
GOOD	16175		18.71	18.63		0.08	4.982			2.800						4.19		
GOOD	16355		18.71				4.983			2.750						4.19		
GOOD	16525		18.71				4.983			2.755						6.19		
GOOD	16725		18.71				4.983			2.754						6.19		
SAND	10020		44.322				42.65			43.045						43.662		
SAND	10020		43.515				43.062			42.64						43.757		
SAND	10520		42.566				42.17			42						42.303		
SAND	10920		41.555				40.477			43.011						40.742		
SAND	11040		40.337				40.201			39.629						40.568		
SAND	11062		40.16				39.643			39.339						39.792		
SAND	11240		39.053				38.497			38.172						38.573		
SAND	11518		38.297				37.662			37.124						37.947		
SAND	11540		37.983				37.386			36.093						37.377		
SAND	11760		37.256				36.669			36.133						36.873		
SAND	11998		36.572				35.759			35.43						35.922		
SAND	12020		35.138				35.556			35.141						35.607		
SAND	12120		35.437				34.902			34.61						35.154		
SAND	12440		34.461				33.985			33.58						34.113		
SAND	12810		32.694				31.554			30.969						31.763		
SAND	13020		30.641				29.856			29.436						30.022		
SAND	13320		29.595				28.901			28.481						28.223		
SAND	13820		27.924				27.594			27.517						27.583		
SAND	14220		25.303				25.736			25.565						25.882		
SAND	14620		24.647				24.122			22.718						24.287		
SAND	14700		24.6				23.907			22.491						24.062		
SAND	14740		24.564				23.9			23.437						24.065		
SAND	14820		24.430				23.845			23.439						23.987		
SAND	15317.78		21.846				21.212			20.839						21.355		
SAND	15815.56		19.251				15.582			18.219						18.729		
SAND	16313.33		16.665				15.944			15.565						18.094		
SAND	16811.11		16.519				13.321			12.879						13.474		
SAND	17308.89		16.519				10.658			10.201						10.814		
SAND	17806.67		16.510				8.098			7.486						8.225		
SAND	18304.45		16.510				5.376			4.308						5.47		
SAND	18802.22		16.519				4.364			2.259						5.301		
SAND	19300		16.519				4.364			2.264						5.309		
WOOG	10000		24.76				23.057			21.908						23.411		
WOOG	10450		24.23				22.601			21.572						22.925		
WOOG	10930		23.35				21.636			20.501						21.919		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	1974 RECORDED WL Left (m AHD)	1974 RECORDED WL Right (m AHD)	1974 DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	1983 RECORDED WL (m AHD)	1983 DIFFERENCE	1989 CALIBRATION EVENT PREDICTED WL (m AHD)	1989 RECORDED WL (m AHD)	1989 DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	1991 RECORDED WL (m AHD)	1991 DIFFERENCE	1995 CALIBRATION EVENT PREDICTED WL (m AHD)	1995 RECORDED WL (m AHD)	1995 DIFFERENCE
WOOG	11150		22.11				20.279			19.02						20.654		
WOOG	11530		20.83				19.137			17.739						19.539		
WOOG	12030		19.82				18.219			16.44						18.556		
WOOG	12130		19.72				18.597			16.71						18.44		
WOOG	12620		18.98				17.392			15.804						17.577		
WOOG	12930		18.52				16.452			15.215						16.857		
WOOG	13070		18.29				16.178			14.975						16.561		
WOOG	13250		18.29				15.075			14.680						16.288		
WOOG	13510		18.29				15.543			14.216						15.938		
WOOG	13550		18.29				15.455			14.103						15.911		
WOOG	13640		18.29	18.24		0.05	15.224			13.761						15.732		
WOOG	13770		18.29				13.05			13.475						15.535		
WOOG	13800		18.29				15.202			13.267						15.568		
WOOG	14300		18.29				14.773			13.003						15.33		
WOOG	14370		18.29				14.457			12.499						15.044		
WOOG	14530		18.29				14.281			12.244						14.824		
WOOG	14580		18.29				14.026			11.956						14.354		
WOOG	14630		18.29				13.143			11.252						13.696		
WOOG	14700		18.29				12.61			10.118						12.578		
WOOG	14850		18.29				11.647			9.878						12.17		
WOOG	14910		18.29				11.556			9.741						12.212		
WOOG	14930		18.29				11.475			9.766						12.23		
WOOG	14950		18.29				11.601			9.712						12.155		
WOOG	15010		18.29				11.584			9.688						12.129		
WOOG	15025		18.29				11.57			9.677						12.105		
WOOG	15050		18.29				11.401			9.532						11.920		
WOOG	15120		18.29				11.234			9.271						11.765		
WOOG	15150		18.29				11.169			9.145						11.729		
WOOG	15230		18.29				11.507			8.996						11.483		
WOOG	15300		18.29				10.753			8.705						11.25		
WOOG	15370		18.29				10.589			8.588						11.144		
WOOG	15470		18.29				10.457			8.474						11.023		
WOOG	15570		18.29	18.8	18.3	-0.18	10.291			8.326						10.843		
WOOG	15600		18.29				9.927			8.1						10.397		
WOOG	15650		18.29	18.6		-0.31												
WOOG	15770	Parker Street	18.29				9.675	10.35	-0.475	7.675						10.363	11.75	-0.887
WOOG	15780		18.29	18.5		-0.21												
WOOG	15820		18.29				9.615			7.468						10.155		
WOOG	15840	Edna Street	18.29				9.707			7.278						10.273	10.01	0.223
WOOG	15850		18.29				9.321			7.251						9.671		
WOOG	15870		18.29	18.7	18.2	-0.16												
WOOG	15960		18.29				8.825			7.093						9.388		
WOOG	15990		18.29				8.851			7.09						9.427		
WOOG	16000		18.29	18.2		0.09												
WOOG	16010		18.29				8.825			7.334						9.491		
WOOG	16125		18.29				8.629			6.68						9.342		
WOOG	16150		18.29				8.716			6.982						9.275		
WOOG	16225		10.29				8.24			6.215						8.987		
WOOG	16277		18.29	18.4	18.2	-0.07												
WOOG	16400		18.29	18.4		-0.11												
WOOG	16440		18.29				7.474			5.323						8.433		
WOOG	16550		18.29	18.3	18.3	-0.01												
WOOG	16660		18.29				7.467			5.131						8.172		
WOOG	16700		18.29		18.3	-0.01	7.284			5.024						8.117		
WOOG	16750		18.29		18.6	[illegible]												
WOOG	16850		18.29		18.8	-0.57	7.059			4.804						7.789		
WOOG	16900		18.29	18.2	18.8	-0.21	6.885			4.651						7.549		
WOOG	17050		18.29				6.510			4.349						7.198		
WOOG	17150		18.29	18.4		-0.11												
WOOG	17225	Brisbane Road	18.29				6.508	5.3	1.208	4.227						7.23	7.3	-0.07
WOOG	17275		18.29				6.257			4.05						6.999		
WOOG	17310		18.29				6.364			4.026						7.643		
WOOG	17370		18.29				6.077			3.745						8.788		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
WOOG	17440		18.29				5.926			3.44						6.587		
WOOG	17450		18.29				5.076			3.952						6.532		
WOOG	17500		18.29				5.906			3.495						6.557		
WOOG	17550		18.29				5.885			3.439						6.5		
WOOG	17580	Brisbane Terrace	18.29				5.802	4.3	1.502	2.341						6.435	6.4	0.035
WOOG	17600		18.29				5.825			3.373						6.45		
WOOG	17615		18.29				5.849			3.383						6.457		
WOOG	17700		18.29	18.57	18.7	-0.35												
WOOG	17750		18.29				5.759			3.341						6.372		
WOOG	17770		18.29				5.714			3.31						6.303		
WOOG	17780		18.29				5.556			3.191						6.271		
WOOG	17850		18.29				5.21			2.885						6.009		
WOOG	17960		18.29				5.196			2.883						6.007		
WOOG	18250		18.29				4.926			2.628						5.974		
WOOG	18300		18.29		18.4	-0.11												
WOOG	18500		18.29				4.819			2.633						5.977		
WOOG	18750		18.29				4.815			2.631						5.975		
WOOG	18930		18.29				4.814			2.629						5.976		
WOOG	19075		18.29				4.811			2.627						5.975		
WAR	100005		28.19				23.576			23.143						23.67		
WAR	100485		27.93	28.64		-0.74												
WAR	100499		27.89				23.101			23.164						23.291		
WAR	100505		27.84		27.807	0.03												
WAR	100735		27.73		27.8	-0.07												
WAR	100973		27.32				22.316			21.891						22.002		
WAR	101284		27.31				22.027			20.651						21.321		
WAR	101285		27.31		27.201	0.11												
WAR	101585		27.28				20.662			20.249						21.019		
WAR	101874		27.28				20.397			19.881						20.77		
WAR	102153		27.27				20.164			19.63						20.625		
WAR	102460		27.27				19.884			19.316						20.419		
WAR	102737		27.26				19.558			18.992						20.182		
WAR	103148.5		27.25				19.303			18.549						20.03		
WAR	103532		27.23				19.143			18.125						19.92		
WAR	103831		27.23				19.063			17.754						19.854		
WAR	104129		27.22				18.993			17.287						19.823		
WAR	104287		27.21				18.975			17.134						19.78		
WAR	104444		27.17				18.91			16.979						19.702		
WAR	104805		27.19				18.933			16.902						19.693		
WAR	105106		27.20				18.399			16.883						19.699		
WAR	105453		27.19				18.353			16.837						19.682		
WAR	105806		27.18				18.854			16.658						19.677		
WAR	106085		27.18		26.632	0.54												
WAR	106363		27.17			-	18.792			16.608						19.607		
WAR	106564		27.17				18.733			16.473						19.519		
WAR	106814		27.17				18.649			16.236						19.46		
WAR	107114		27.17				18.533			16.028						19.379		
WAR	107424		27.17				18.157			15.474						18.971		
WAR	107474		27.17				15.244			15.447						19.045		
WAR	107672		27.17				15.483			15.46						19.34		
WAR	107722		27.17				18.51			15.515						19.356		
WAR	108070		27.17				18.322			15.564						19.363		
WAR	108140		27.17				15.503			15.544						19.349		
PURGA	100200		27.244				23.362			22.446						24.307		
PURGA	100432		27.232				22.985			22.133						23.872		
PURGA	100773		27.223				22.625			21.817						23.454		
PURGA	101113		27.215				22.158			21.371						22.909		
PURGA	101479		27.21				21.838			20.826						22.364		
PURGA	101845		27.204				20.955			20.084						21.749		
PURGA	102174		27.189				20.232			18.958						21.016		
PURGA	102502		27.195				18.809			16.883						19.696		
WARLBK	0		27.037				18.244			15.447						19.049		
WARLBK	300		27.129				18.485			15.48						19.34		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	1974 RECORDED WL Left (m AHD)	1974 RECORDED WL Right (m AHD)	1974 DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	1983 RECORDED WL (m AHD)	1983 DIFFERENCE	1988 CALIBRATION EVENT PREDICTED WL (m AHD)	1988 RECORDED WL (m AHD)	1988 DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	1991 RECORDED WL (m AHD)	1991 DIFFERENCE	1996 CALIBRATION EVENT PREDICTED WL (m AHD)	1996 RECORDED WL (m AHD)	1996 DIFFERENCE
FP1WAR	50		27.131				18.533			19.028						19.320		
FP1WAR	150		27.166				18.522			13.564						15.365		
PWLINK1	0		27.223				22.625			21.817						23.454		
PWLINK1	1		27.226				19.095			17.764						19.854		
PWLINK5	9		27.159				20.232			18.958						21.016		
PWLINK2	1		27.189				18.903			16.902						18.609		
PWLINK2	0		27.21				21.609			20.806						22.594		
PWLINK2	1		27.215				18.375			17.134						19.78		
BREMBRSLINK1	0		35.85				5.636			3.363						6.393		
BREMBRSLINK1	150		19.874				5.527			3.289						6.856		
BREMLINKBRANCH1	0		20.442				9.463			6.589						10.708		
BREMLINKBRANCH1	10		20.388				9.218			6.225						10.765		
BREMLINKBRANCH2	0		20.424				9.604			6.521						10.63		
BREMLINKBRANCH2	50		20.388				9.281			6.268						10.283		
BUND	10030		81.45				80.539			80.66			80.949			80.341		
BUND	10615		77.29				75.058			76.02			76.445			75.279		
BUND	11600		74.42				72.025			72.876			73.402			73.185		
BUND	12705		68.63				67.453			67.635			68.422			68.136		
BUND	13165		67.83				65.811			68.053			66.742			66.484		
BUND	13945		52.18				50.016			50.374			51.088			46.31		
BUND	14405		58.83				57.372			57.503			58.125			57.207		
BUND	14775		57.32				55.467			56.553			56.613			56.722		
BUND	15056		57.08				55.775			55.854			56.322			54.19		
BUND	15700		56.83				55.056			55.243			55.89			55.696		
BUND	16395	Ripley	54.86				52.537			52.776			53.656			53.368	24.5	28.868
BUND	16900		53.44				51.448			51.586			57.566			52.291		
BUND	17215		52.61				50.48			50.726			51.644			51.341		
BUND	17530		51.89				49.317			49.536			50.473			50.201		
BUND	17835		50.25				48.324			48.645			49.35			49.18		
BUND	18732		49.19				46.478			46.758			47.635			47.89		
BUND	18750		48.11				46.252			46.75			47.294			47.056		
BUND	19015		47.16				45.140			45.435			46.25			45.975		
BUND	19200		46.65				43.909			44.12			44.889			44.637		
BUND	19540		44.65				43.065			43.280			43.93			43.715		
BUND	19800		44.16				42.445			42.620			43.302			43.097		
BUND	20120		43.40				41.811			41.95			42.587			42.434		
BUND	20440		42.82				41.37			41.454			42.106			41.876		
BUND	20925		41.85				40.565			40.658			41.257			41.023		
BUND	21370		40.74				39.537			39.431			40.091			35.7		
BUND	22085		39.34				37.835			37.731			38.411			38.096		
BUND	22085		39.34				37.835			37.731			38.411			38.096		
BUND	22120		39.31				37.568			37.665			38.309			38.042		
BUND	22785		38.75				36.788			36.879			37.717			37.36		
BUND	23150		38.42				36.24			36.508			37.379			37.02		
BUND	23515		38.11				35.172			36.275			37.361			36.705		
BUND	24130		36.80				34.953			35.377			35.816			35.478		
BUND	24445		35.24				33.259			33.353			34.155			33.79		
BUND	24780		33.78				32.046			32.107			32.838			32.566		
BUND	25075		32.78				31.443			31.49			32.058			31.756		
BUND	25530		32.77				30.833			30.838			31.132			31.317		
BUND	25830		31.75				30.65			30.651			31.149			30.921		
BUND	26075		30.67				29.547			29.849			30.228			29.993		
BUND	26540		29.70				28.345			28.34			28.967			28.673		
BUND	26783		29.19				27.579			27.649			28.422			28.032		
BUND	27180		28.74		29	-0.26												
BUND	27280		28.82				27.416			27.383			28.097			27.741		
BUND	27330		25.58	25.6		-0.22												
BUND	27380		28.33				27.376			27.349			28.049			27.867		
BUND	27400		28.45				27.125			27.103			27.732			27.409		
BUND	27655		28.65				26.852			25.834			27.386			27.594		
BUND	27675		27.98				26.803			25.765			27.326			27.042		
BUND	28010		27.32				26.219			25.198			26.814			25.505		
BUND	28200		27.08				26.007			25.18			26.63			25.379		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1986 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ BASIS	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BUND	28250		27.00				26.007			25.68			26.83			26.318		
BUND	28440		26.80				25.821			25.59			26.265			26.005		
BUND	28450		26.65				25.575			25.547			26.335			25.97		
BUND	28480		26.50				25.559			25.508			26.015			25.949		
BUND	28540		26.39				25.335			25.122			25.705			25.407		
BUND	28560		25.35				25.161			25.125			25.723			25.472		
BUND	28900		25.78				24.576			24.841			25.242			24.935		
BUND	29240	Harding Street	25.28				24.218	24.3	-0.664	24.180	23.85	0.330	24.8			24.471	24.5	-0.029
BUND	29250		25.17	25.2	25.6	0.23												
BUND	29400		24.85		25.1	-0.25												
BUND	29550		24.73				23.583			23.587			24.286			23.892		
BUND	29650		23.88	23.6		0.08												
BUND	29810		23.88				22.716			22.056			23.237			22.653		
BUND	30080		23.43		23.4	0.03												
BUND	30215		23.21				21.58			21.462			22.415			21.923		
BUND	30480		22.04	21.4		-0.36												
BUND	30510		22.91		24	-1.09												
BUND	30520		22.90				21.320			21.211			22.106			21.457		
BUND	30580		22.45	23.7		-0.86												
BUND	30780		22.71	23.1		-0.39												
BUND	30940		22.53				20.983			20.878			21.878			21.322		
BUND	31350		22.33				20.679			20.555			21.558			21.033		
BUND	31480		22.21		23.4	-1.19												
BUND	31880		22.12	22.1		0.02												
BUND	31930		22.07				20.329			20.181			21.287			20.738		
BUND	31980	Blackstone Road	21.79	21.5		0.29	19.806	20.0	-0.194	19.702	19.4	0.302	21.062	20.92	0.142	20.435	20.7	-0.265
BUND	32000		21.58				19.712			19.557			20.737			20.123		
BUND	32140		21.42		21.1	0.32												
BUND	32150		21.40				19.475			19.326			20.438			19.85		
BUND	32190		21.38	21.1		0.28												
BUND	32350		21.20				19.226			19.063			20.32			19.647		
BUND	32370		21.15				19.211			19.048			20.276			19.627		
BUND	32875		20.82				18.712			18.543			19.811			19.161		
BUND	32980		20.37				18.085			17.985			19.207			18.535		
BUND	33319		20.37	20.5		-0.13												
BUND	33329		20.37				17.141			20.932			18.768			17.598		
BUND	33489		20.37	20.5		-0.13												
BUND	33669		20.37				16.864			16.67			17.876			17.359		
BUND	33930		20.37		20.5	-0.13												
BUND	33950		20.37				16.747			16.495			17.838			17.242		
BUND	34000		20.37	20.5		-0.13	16.722			16.403			17.805			17.219		
BUND	34030		20.37		20.5	-0.13												
BUND	34280	Brisbane Road	20.37				16.592	16.2	0.392	16.201	15.37	0.831	17.756	17.58	0.176	17.16	17.45	-0.31
BUND	34290		20.37		20.6	-0.23												
BUND	34065		20.37				16.588			15.296			17.753			17.138		
BUND	34345		20.37				16.255			16.051			17.133			16.589		
BUND	34390		20.37	20.5	20.4	-0.13												
BUND	34395		20.37				16.075			15.881			16.837			16.393		
BUND	34430		20.37		20.5	-0.13												
BUND	34480		20.37		20.4	-0.03												
BUND	34708		20.37	20.6	20.6	-0.23	15.342			15.15			16.24			15.645		
BUND	35050		20.37				14.514			14.334			15.597			14.843		
BUND	35080		20.37	20.5		-0.13												
BUND	35100		20.37				14.356			14.17			15.626			14.742		
BUND	35120		20.37				14.306			14.101			15.26			14.561		
BUND	35510		20.37	20.4		-0.03												
BUND	35520		20.37				13.456			13.239			14.588			13.891		
BUND	35540		20.37				13.436			13.22			14.438			13.821		
BUND	35730		20.37				12.851			12.037			13.877			13.231		
BUND	35825		20.37				12.841			11.738			13.427			12.555		
BUND	36010		20.32	20.5	20.7	-0.24												
BUND	36025	Gladstone Street	20.32				11.934	12.2	-0.766	11.876			13.057			12.388		
BUND	38570		20.32				10.881			10.829			11.977			11.357		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	1982 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1989 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1996 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
BUND	35640		20.37				10.237			9.914			11.262			10.77		
BUND	37110		20.37				10.002			9.634			11.016			10.581		
BUND	37140		20.37		20.1	0.26												
BUND	37480		20.37				9.728			9.272			10.912			10.421		
BUND	37810		20.37				9.452			8.853			10.990			10.175		
BUND	37910		20.37				9.318			8.236			10.9			10.108		
BUND	37900		20.37		20.5	-0.14												
BUND	38260		20.37				9.173			7.487			10.896			10.038		
BUND	39125		20.36				9.033			6.38			10.885			9.47		
BUND	40310		20.34				8.983			6.053			10.863			8.944		
BUND	40670		20.35				8.973			6.022			10.863			8.832		
BUND	41030		20.26				8.958			5.987			10.863			8.931		
HWAY LEFT	0		26.485				25.548			25.509			26.370			25.582		
HWAY LEFT	170		26.46				25.204			25.13			26.376			25.503		
HWAY LEFT	260		26.46				25.188			25.13			26.376			25.506		
HWAY LEFT	290		26.407				25.191			25.129			25.37			25.495		
HWAY LEFT	310		26.392				25.152			25.125			25.743			25.477		
HWAY LEFT	330		26.370				25.161			25.125			25.735			25.475		
HWAY LEFT	399		26.345				25.161			25.125			25.723			25.422		
LOW BRANCH1	0		20.389				9.565			6.333			10.903			10.175		
LOW BRANCH1	153		20.385				9.452			6.653			10.903			10.175		
LOW BRANCH1	480		20.385				9.452			6.853			10.903			10.175		
LOW BRANCH2	0		21.701				21.445			21.411			21.467			21.429		
LOW BRANCH2	240		20.367				19.09			19.87			19.314			19.083		
LOW BRANCH2	740		25.367				18.747			18.495			17.836			17.242		
UP BRANCH1	0		47.447				46.784			46.894			47.159			47.181		
UP BRANCH1	475		45.263				44.83			44.890			45.051			45.644		
UP BRANCH1	890		43.056				42.903			42.828			42.924			42.925		
UP BRANCH1	1400		39.83				39.48			39.538			38.939			39.027		
UP BRANCH1	1850		39.34				37.658			37.75			38.419			38.112		
UP BRANCH1	2280		38.338				37.635			37.731			38.411			38.096		
BUND#	0		26.48				25.199			25.33						25.506		
BUND#	90		26.906				25.067			25.98						26.316		
REEDY	1009		26.471				26.60			26.898						25.586		
REEDY	1244.5		25.831				25.389			25.398						25.302		
REEDY	1520		24.91				24.104			24.179						24.71		
REEDY	1542		24.91				24.056			24.073						24.804		
REEDY	1949		24.903				24.583			24.583						24.383		
REEDY	2139		24.958				24.958			24.968						24.965		
SMALL	1000		24.902				22.381			22.372						22.098		
SMALL	1226		24.902				21.206			21.283						21.158		
SMALL	1257		24.902				20.989			20.987						20.868		
SMALL	1409		24.902				18.573			18.675						19.463		
SMALL	1624		24.902				17.881			17.88						17.748		
SMALL	1670		24.902				17.568			17.582						17.445		
SMALL	1898		24.902				15.893			15.957						16.578		
SMALL	1990		24.902				15.857			15.9						18.527		
SMALL	2128		24.902				15.835			15.802						18.577		
DEEP	10000		46.268				45.777			45.85						45.867		
DEEP	10345		45.709				45.28			45.442						45.714		
DEEP	10588.5		43.059				42.687			42.737						42.835		
DEEP	10992		41.962				40.828			40.892						40.761		
DEEP	11141		40.924				40.581			40.637						40.529		
DEEP	11453		40.229				40.017			40.054						39.974		
DEEP	11807		38.235				35.663			35.749						35.567		
DEEP	12131		34.727				33.857			34.057						33.823		
DEEP	12372		32.384				31.68			31.703						31.586		
DEEP	12643		29.985				29.318			29.414						29.229		
DEEP	12867		29.198				27.592			27.881						27.526		
DEEP	12947		27.957				27.25			27.374						27.354		
DEEP	13146		26.643				25.929			26.643						25.834		
DEEP	13295		26.317				25.48			25.889						25.398		
DEEP	13547		26.37				25.342			25.474						25.259		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	1974 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	1983 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1989 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1991 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	1996 CALIBRATION EVENT PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
DEEB	13868		25.109				24.329			24.996						24.727		
DEEB	13922		24.969				24.38			24.479						24.314		
DEEB	14201		24.904				23.658			23.73						23.611		
DEEB	14496		24.903				22.254			22.298						22.228		
DEEB	14771		24.903				20.811			20.834						20.872		
DEEB	14979		24.902				20.134			20.279						20.035		
DEEB	15159		24.902				19.061			19.218						19.02		
DEEB	15338		24.902				19.7			18.851						18.638		
DEEB	15482		24.902				18.508			18.66						18.448		
DEEB	15602		24.902				18.411			18.547						18.254		
DEEB	15904		24.902				17.988			18.179						17.937		
DEEB	16035		24.902				17.821			17.981						17.273		
DEEB	16195		24.902				17.332			17.528						17.338		
DEEB	16215		24.902				17.304			17.44						17.28		
DEEB	16343		24.902				17.093			17.322						17.044		
DEEB	16349		24.902				16.924			17.075						16.929		
DEEB	16509		24.902				16.297			16.382						16.618		
DEEB	16625		24.902				16.238			16.378						16.617		
DEEB	16643		24.902				16.23			16.37						16.678		
DEEB	16854		24.902				15.944			16.018						16.585		
DEEB	16950		24.902				15.904			15.965						16.586		
DEEB	17054		24.902				15.885			15.937						16.584		
DEEB	17077		24.902				15.854			15.892						16.577		
DEEB	17093		24.902				15.847			15.878						16.578		
DEEB	17317		24.901				15.713			15.801						16.567		
DEEB	17690		24.897				15.608			15.197						16.56		
DEEB	17579		24.901				15.600			15.274						16.561		
DEEB	17697		24.901				15.550			15.101						16.398		
DEEB	17717		24.896				18.579			14.675						16.553		
DEEB	17902		24.856				15.568			14.479						16.551		
DEEB	17927		24.892				15.554			14.13						16.548		
DEEB	18337		24.881				15.545			13.878						16.544		
DEEB	18357		24.888				15.538			13.82						16.54		
DEEB	18478		24.885				15.532			13.688						16.539		
DEEB	18502		24.881				15.525			12.826						16.534		
DEEB	18560		24.881				15.525			12.481						16.534		
DEEB	18670		24.883				15.525			12.159						16.533		
DEEB	18795		24.879				15.524			12.023						16.533		
DEEB	18936		24.885				15.527			11.918						16.533		
DEEB	19112		24.857				15.52			11.912						16.532		
DEEB	19132		24.849				15.515			11.864						16.529		
DEEB	19157		24.843				15.515			11.903						16.529		
DEEB	19247		24.775				15.514			11.898						16.522		
DEEB	19404		24.806				15.514			11.804						16.52		
DEEB	19537		24.786				15.513			11.893						16.515		
DEEB	19607		24.821				15.513			11.823						16.516		
DEEB	19702		24.78				15.513			11.895						16.514		
DEEB	19827		24.786				15.513			11.893						16.514		
DEEB	19847		24.764				15.506			11.891						16.501		
DEEB	19912		24.774				15.508			11.891						16.503		
DEEB	20912		24.771				15.506			11.892						16.533		
IRONPOT BR1	1000		80.505				80.484			80.426						80.485		
IRONPOT BR1	1379		69.775				69.67			69.547						69.709		
IRONPOT BR1	1618		59.932				59.804			59.79						58.804		
IRONPOT BR1	1652		54.125				53.419			53.653						53.838		
IRONPOT BR1	1883		52				52.768			52.9						52.861		
IRONPOT BR1	2182		48.855				48.823			49.714						49.858		
IRONPOT BR1	2453		45.678				45.383			45.343						45.478		
IRONPOT BR1	2491		45.455				45.382			45.338						45.418		
IRON	10000		75.158				75.687			75.06						75.133		
IRON	10274		69.819				69.282			69.754						69.802		
IRON	10363		63.984				63.04			63.917						63.962		
IRON	10725		59.696				59.658			59.643						58.684		

Table D-7 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
IRON	11001		49.702				49.811			49.814						49.841		
IRON	11274		45.455				45.362			45.338						45.418		
IRON	11422		44.352				44.765			44.743						44.817		
IRON	11765		40.436				40.25			40.196						40.364		
IRON	11794		40.345				40.17			40.108						40.276		
IRON	12057		39.715				39.569			39.553						39.662		
IRON	12335		35.996				35.789			35.755						35.925		
IRON	12615		32.705				32.269			32.222						32.55		
IRON	12658		32.625				32.228			32.184						32.484		
IRON	12952.5		31.392				31.131			31.102						31.300		
IRON	13267		30.218				30.022			30.003						30.102		
IRON	13766		26.589				26.125			26.075						26.421		
IRON	14107		25.976				25.802			25.58						25.334		
IRON	14456		24.078				23.561			23.529						23.934		
IRON	14865		22.776				21.488			21.45						21.854		
IRON	15130		22.777				20.573			20.536						20.812		
IRON	15407		22.777				20.322			20.254						20.545		
IRON	15700		22.776				18.713			18.551						18.874		
IRON	15887		22.776				16.336			16.323						18.784		
IRON	16158.5		22.775				14.325			14.467						14.798		
IRON	16510		22.775				13.093			12.379						14.105		
IRON	16827		22.775				13.06			10.945						14.103		
IRON	17093		22.775				13.059			10.318						14.103		
IRON	17336		22.775				13.058			9.975						14.103		
IRON	17528		22.775				13.058			9.428						14.103		
IRON	17854		22.775				13.057			9.425						14.103		
IRON	18031		22.776				13.057			9.424						14.103		
IRON	18155		22.776				13.057			9.420						14.103		
IRON	18263		22.776				13.057			9.423						14.103		
IRON	18363		22.776				13.057			9.422						14.103		
IRON	18364		22.770				13.055			9.410						14.101		
IRON	18584		22.776				13.055			9.410						14.101		
MNH	10000		28.130				28.21			27.992						27.977		
MNH	10192		26.475				26.236			26.201						26.155		
MNH	10513		22.27				22.13			22.109						22.106		
MNH	10711		21.577				19.07			19.015						19.021		
MNH	10747		21.575				18.867			18.855						18.85		
MNH	10887		21.578				18.76			18.705						16.604		
MNH	11000		21.576				15.402			15.347						15.347		
MNH	11117		21.576				14.481			14.4						14.393		
MNH	11277		21.576				12.876			12.774						12.834		
MNH	11310		21.576				12.536			12.482						12.827		
MNH	11466		21.576				11.788			11.559						12.827		
MNH	11708		21.576				11.785			10.734						12.826		
MNH	11958		21.576				11.785			9.874						12.826		
MNH	12135		21.576				11.784			9.051						12.826		
MNH	12230		21.575				11.784			8.579						12.826		
MNH	12405		21.574				11.784			8.553						12.826		
MNH	12630		21.573				11.784			8.338						12.826		
MNH	12734		21.573				11.784			8.338						12.826		
MNH	12921		21.573				11.784			8.338						12.826		
MNH	13120		21.571				11.784			8.338						12.826		
MNH_BR1	1202		35.073				35.073			35.073						35.073		
MNH_BR1	1352		34.881				34.581			34.482						34.507		
MNH_BR1	1412		33.102				33.052			33.005						33.02		
MNH_BR1	1471		32.55				32.411			32.367						32.388		
MNH_BR1	1827		26.826				26.79			26.76						26.79		
MNH_BR1	2072		23.374				23.241			23.224						23.277		
MNH_BR1	2346		21.579				19.987			19.94						19.959		
MNH_BR1	2563		21.577				16.164			16.117						16.121		
MNH_BR1	2587		21.576				15.834			15.793						15.794		
MNH_BR1	2700		21.576				15.423			15.347						15.341		
SCH	10000		29.88				29.75			29.738						29.734		

Table D-1 Predicted and Recorded Flood Levels for Calibration Events

			1974 CALIBRATION EVENT				1983 CALIBRATION EVENT			1989 CALIBRATION EVENT			1991 CALIBRATION EVENT			1996 CALIBRATION EVENT		
RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	PREDICTED WL (m AHD)	RECORDED WL Left (m AHD)	RECORDED WL Right (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE	PREDICTED WL (m AHD)	RECORDED WL (m AHD)	DIFFERENCE
SCH	10340		21.811				21.408			21.37						21.358		
SCH	10920		20.355				18.174			18.155						18.147		
SCH	10870		20.302				17.537			17.504						17.494		
SCH	11110		20.362				15.995			15.978						15.951		
SCH	11382.8		20.362				15.313			15.29						15.285		
SCH	11610		20.362				14.472			14.39						14.428		
SCH	11887		20.362				10.174			10.121						10.095		
SCH	11927		20.362				9.57			9.927						9.923		
SCH	12167		20.362				9.728			9.657						9.919		
SCH	12287		20.362				9.292			9.218						9.917		
SCH	12435		20.362				8.953			8.852						9.916		
SCH	12462.8		20.362				8.905			8.761						9.913		
SCH	12855.6		20.361				8.831			7.837						9.912		
SCH	13050		20.361				8.837			6.203						9.912		
SCH	13260		20.361				8.937			6.312						9.912		
SCH	13209		20.361				8.937			6.22						9.912		
SCH	13598.3		20.361				8.937			5.944						9.912		
SCH	13750		20.361				8.937			5.944						9.912		
SCH	13757		20.361				8.937			5.944						9.912		
SCH	13972		20.361				8.936			5.943						9.912		
MPH_LINK1	0		21.576				11.784			9.061						12.920		
MPH_LINK1	30		21.626				11.884			8.406						12.926		
SCH_LK1	0		20.361				8.657			5.944						9.912		
SCH_LK1	30		20.362				8.549			5.35						9.924		
DEEBING_LK1	0		24.851				16.14			12.216						16.982		
DEEBING_LK1	30		24.840				15.515			11.933						16.523		
DEEBING_LK2	0		24.533				16.256			12.503						17.228		
DEEBING_LK2	30		24.861				15.529			12.481						18.554		
DEEBING_LK3	0		25.215				15.703			13.161						17.338		
DEEBING_LK3	30		24.901				15.809			15.214						16.561		
DEEBING_LK4	0		24.902				15.904			15.564						18.586		
DEEBING_LK4	30		24.902				15.857			15.9						18.577		
DEEBING_LK5	0		24.902				16.23			16.37						18.615		
DEEBING_LK5	30		24.902				17.881			17.59						17.748		
DEEBING_LK7	0		24.902				18.411			18.542						18.254		
DEEBING_LK7	30		24.91				24.104			24.179						24.11		
WOOG_LK1	0		18.287				14.773			13.003						15.33		
WOOG_LK1	30		18.287				11.234			9.271						11.765		
WOOG_LK2	0		18.287				15.05			12.415						15.585		
WOOG_LK2	30		18.287				14.008			11.996						14.554		
DEEBING_LK6	0		24.902				17.871			17.963						17.773		
DEEBING_LK6	30		24.903				17.656			17.974						17.788		
BREMBRISZ	0		19.95				5.026			3.363						8.833		
BREMBRISZ	142.16		79.912				5.517			3.255						8.845		
SANDY CHIRWAR_LK2	0		20.361				8.937			4.323						8.912		
SANDY CHIRWAR_LK2	61.55		20.362				8.943			5.90						8.924		

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BNE	965390		7559.04		1515.672	1190.978	2154.751
BNE	967010		7554.12		1513.335	1190.947	2153.656
BNE	968600		7551.20		1510.914	1190.91	2152.445
BNE	970475		7548.62		1508.747	1190.868	2159.675
BNE	971710		7545.37		1507.24	1190.84	2158.926
BNE	972760		7543.69		1505.665	1190.809	2158.04
BNE	973920		7541.16		1503.621	1190.775	2156.844
BNE	975300		7539.48		1502.467	1190.78	2156.019
BNE	976385		7536.71		1501.54	1190.768	2155.364
BNE	977515		7532.32		1499.992	1190.774	2154.141
BNE	978693.5		7544.34		1499.068	1191.437	2154.66
BNE	979510		7770.51		1498.103	1199.713	2189.699
BNE	979521.5		7767.48		1498.096	1199.427	2187.425
BNE	979930		7534.74		1497.692	1191.919	2165.188
BNE	980095		7525.09		1496.305	1190.762	2152.185
BNE	982060		7522.58		1495.462	1190.767	2151.78
BNE	983310		7519.15		1494.628	1190.72	2157.558
BNE	984710		7517.74		1493.35	1190.575	2156.795
BNE	985870		7516.49		1492.538	1190.564	2156.229
BNE	987220		7514.91		1491.784	1190.564	2155.63
BNE	988060		7513.46		1491.095	1190.555	2155.145
BNE	988165	Mt Crosby	7513.23		1491.039	1190.554	2155.102
BNE	988265		7513.02		1490.985	1190.554	2155.061
BNE	989030		7511.64		1490.395	1190.58	2154.635
BNE	990200		7509.33		1488.910	1190.724	2153.747
BNE	990730		7508.66		1488.55	1190.783	2153.569
BNE	991235		7508.23		1488.269	1190.837	2153.403
BNE	992065		7506.77		1487.516	1191.017	2152.944
BNE	992435		7532.69		1487.211	1191.114	2152.755
BNE	992460		7537.32		1487.197	1191.119	2152.746
BNE	992570		7511.68		1487.131	1191.141	2152.706
BNE	993215		7505.39		1486.86	1191.20	2152.586
BNE	994260		7504.24		1486.568	1191.424	2152.471
BNE	995225		7502.91		1486.059	1191.843	2152.381
BNE	996335		7502.28		1485.769	1192.226	2152.409
BNE	997720		7501.25		1485.37	1193.002	2152.645
BNE	998810		7500.45		1484.943	1194.633	2153.372
BNE	999580		7500.17		1484.867	1195.203	2153.74
BNE	1000142.5		7500.25		1485.139	1195.675	2183.488
BNE	1000530		7500.08		1485.126	1196.247	2183.7
BNE	1001045		7499.94		1485.107	1196.784	2184.023
BNE	1001690		7499.75		1485.135	1197.747	2184.565
BNE	1002107.5		7499.60		1485.155	1198.275	2184.865
BNE	1002567.5		7499.48		1485.177	1198.831	2185.181
BNE	1003030		7499.38		1485.212	1199.715	2185.681
BNE	1003525		7499.28		1485.246	1200.448	2186.098
BNE	1004037.5		7499.19		1485.305	1201.464	2186.662
BNE	1004555		7499.14		1485.349	1202.309	2187.107
BNE	1005067.5		7499.09		1485.419	1203.753	2187.792
BNE	1005597.5		7499.04		1485.508	1205.625	2188.844
BNE	1006035		6977.44		1485.569	1208.943	2189.542
BNE	1006250	Moggill	9483.38		2353.937	1491.174	3030.786
BNE	1006605		9756.52		2351.918	1491.319	3030.409
BNE	1007160		9753.95		2348.714	1491.549	3029.739
BNE	1007595		9751.24		2344.05	1491.766	3028.882
BNE	1007850		9736.61		2349.257	1494.691	3031.331
BNE	1008182.5		9734.94		2347.692	1494.931	3031.06
BNE	1008685		9733.38		2345.028	1495.351	3030.649
BNE	1009162.5		9731.98		2343.308	1496.041	3030.381
BNE	1009560		9730.29		2341.03	1496.307	3030.031
BNE	1010105		9727.09		2338.089	1496.889	3029.537
BNE	1010607.5		9725.59		2335.914	1497.401	3029.187
BNE	1010852.5		9724.74		2334.781	1497.673	3029.016
BNE	1011245		9723.59		2332.858	1498.133	3028.726

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BNE	1011745		9721.45		2329.922	1498.697	3028.227
BNE	1012227.5		9718.84		2326.872	1499.588	3027.674
BNE	1012705		9694.45		2326.293	1503.001	3028.789
BNE	1013062.5		9692.54		2324.528	1503.655	3028.414
BNE	1013317.5		9441.23		2323.333	1504.069	3028.142
BNE	1013562.5		9438.69		2322.283	1504.533	3027.876
BNE	1013795		9335.81		2320.633	1505.286	3027.603
BNE	1014110		9331.82		2317.573	1506.873	3028.839
BNE	1014460	Goodna Hospital (1014610)	9327.58		2315.084	1508.532	3028.221
BNE	1014850		9294.07		2338.973	1514.552	3041.031
BNE	1015325		9291.70		2337.252	1515.696	3040.669
BNE	1015705		9290.60		2336.059	1516.63	3040.426
BNE	1015995		9398.46		2335.104	1517.356	3040.225
BNE	1016390		9394.74		2333.937	1518.484	3039.931
BNE	1016765		9392.67		2332.191	1519.936	3039.493
BNE	1017010		9652.65		2331.199	1520.846	3039.222
BNE	1017370		9650.65		2329.665	1521.995	3038.817
BNE	1017765		9647.70		2328.606	1523.041	3038.551
BNE	1018060		9645.95		2327.73	1523.789	3038.355
BNE	1018462.5		9644.03		2326.373	1525.051	3038.022
BNE	1018910		9642.57		2325.113	1526.264	3037.755
BNE	1019292.5		9641.22		2335.261	1528.311	3038.635
BNE	1019677.5		9637.06		2337.498	1531.64	3040.069
BNE	1019990		9636.32		2335.476	1532.469	3039.909
BNE	1020320		9634.57		2333.018	1534.202	3039.473
BNE	1020677.5		9632.79		2330.747	1536.939	3039.001
BNE	1020962.5		9631.99		2329.46	1538.12	3038.808
BNE	1021317		9631.25		2328.208	1539.198	3038.621
BNE	1021627		9630.28		2326.813	1540.424	3038.42
BNE	1021805		9629.79		2325.861	1541.242	3038.288
BNE	1022000		9629.41		2324.813	1542.066	3038.169
BNE	1022340		9628.85		2323.543	1543.148	3038.024
BNE	1022807.5		9628.39		2362.571	1557.057	3040.718
BNE	1023305		9626.99		2360.952	1558.302	3040.536
BNE	1023825		9626.23		2359.016	1559.834	3040.337
BNE	1024321.5		9625.42		2356.818	1561.556	3040.137
BNE	1024816.5		9624.25		2354.349	1563.478	3039.913
BNE	1025215		9622.83		2352.126	1565.243	3039.718
BNE	1025476		9622.88		2350.993	1566.093	3039.615
BNE	1025880		9621.66		2349.449	1567.244	3039.477
BNE	1026425		9620.72		2346.886	1569.103	3039.297
BNE	1026790		9623.08		2344.974	1584.254	3039.223
BNE	1027030		9623.95		2343.738	1585.016	3039.138
BNE	1027420		9622.62		2342.051	1586.205	3039.022
BNE	1027930		9522.94		2336.368	1588.779	3038.771
BNE	1028430		9531.06		2334.318	1591.523	3038.495
BNE	1028720		9767.51		2332.731	1592.628	3038.387
BNE	1028980		9348.91		2331.098	1593.715	3038.276
BNE	1029440		9627.10		2331.539	1595.419	3038.113
BNE	1029950		9621.37		2332.748	1597.361	3037.927
BNE	1030545		9609.78		2334.579	1599.81	3037.49
BNE	1031065		9602.67		2336.074	1602.433	3037.228
BNE	1031480		9601.07		2336.933	1604.024	3037.071
BNE	1031847.5		9600.54		2337.562	1605.145	3036.958
BNE	1032112.5		9599.46		2338.223	1606.386	3036.828
BNE	1032407.5		9597.62		2339.036	1607.949	3036.66
BNE	1032832.5		9596.94		2339.77	1609.626	3036.504
BNE	1033225		9594.99		2340.451	1611.232	3036.356
BNE	1033535		9593.45		2341.212	1613.142	3036.186
BNE	1034135		9592.08		2341.942	1615.176	3036.009
BNE	1034630		9591.40		2342.928	1617.3	3035.83
BNE	1035152		9589.01		2344.252	1619.697	3035.62
BNE	1035657		9587.70		2345.507	1622.184	3035.4
BNE	1036180		9585.98		2346.704	1624.452	3035.197

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BNE	1036615		9584.84		2347.647	1626.654	3035.013
BNE	1036842.5		9583.90		2348.347	1628.211	3034.866
BNE	1037002.5		9583.76		2354.729	1629.091	3052.174
BNE	1037110		9583.46		2354.916	1630.139	3052.094
BNE	1037230		9583.27		2355.14	1630.688	3051.997
BNE	1037455		9582.91		2355.598	1631.831	3051.796
BNE	1037855		9581.89		2356.677	1634.525	3051.297
BNE	1038342.5		9576.24		2357.892	1637.79	3050.696
BNE	1038850		9571.23		2359.686	1641.757	3049.773
BNE	1039150		9567.77		2361.806	1644.268	3049.133
BNE	1039382.5		9391.75		2363.554	1646.743	3048.612
BNE	1039617.5		9389.16		2365.275	1649.12	3048.078
BNE	1039749		9177.10		2366.199	1650.582	3047.788
BNE	1039959		8987.79		2702.984	1750.161	3112.314
BNE	1040170		8987.12		2705.404	1752.226	3112.325
BNE	1040370		8861.59		2707.552	1753.928	3112.336
BNE	1040750		8860.60		2711.162	1756.339	3112.358
BNE	1041120		8859.23		2714.764	1759.778	3112.487
BNE	1041345		8858.12		2717.198	1762.088	3112.545
BNE	1041580		8857.47		2719.651	1764.37	3112.622
BNE	1041830		8856.86		2721.666	1766.275	3112.697
BNE	1042097.5		8856.18		2723.617	1769.131	3112.748
BNE	1042367.5		8855.60		2725.314	1769.867	3112.801
BNE	1042507.5		8980.39		2726.404	1771.024	3112.834
BNE	1042712.5		8979.95		2728.014	1772.74	3112.883
BNE	1042860		8979.30		2730.04	1775.026	3112.944
BNE	1043045		9210.44		2730.737	1775.814	3112.965
BNE	1043095		9210.31		2731.148	1776.28	3112.977
BNE	1043417.5		9399.66		2733.811	1779.31	3113.057
BNE	1043892.5		9398.74		2738.033	1784.277	3113.182
BNE	1044200		9398.25		2740.527	1787.16	3113.256
BNE	1044472.5		9397.76		2742.555	1789.570	3113.316
BNE	1044732.5		9397.08		2744.803	1792.207	3113.385
BNE	1045130		9395.51		2748.879	1797.089	3113.503
BNE	1045642.5		9393.05		2754.886	1803.991	3113.727
BNE	1046032.5		9390.62		2760.145	1808.657	3113.935
BNE	1046260		9389.43		2763.12	1811.698	3114.035
BNE	1046400		9388.98		2765.338	1813.697	3114.11
BNE	1046740		9388.02		2769.323	1817.771	3114.244
BNE	1047125		9386.68		2774.339	1822.82	3114.414
BNE	1047632.5		9385.24		2779.136	1827.713	3114.577
BNE	1048145		9382.69		2783.626	1832.2	3114.729
BNE	1048632.5		9379.15		2789.888	1838.875	3114.948
BNE	1049005		9377.28		2795.129	1844.442	3115.136
BNE	1049245		9376.20		2798.087	1847.625	3115.244
BNE	1049480		9375.39		2802.371	1849.92	3115.327
BNE	1049730		9374.24		2805.848	1852.361	3115.414
BNE	1050150		9372.74		2812.289	1856.725	3115.572
BNE	1050645		9370.12		2823.33	1870.537	3115.831
BNE	1051110		9368.22		2833.637	1884.914	3123.077
BNE	1051627.5		9365.23		2842.926	1897.096	3123.223
BNE	1052102.5		9362.63		2851.989	1908.28	3123.364
BNE	1052370		9361.35		2858.221	1915.727	3123.448
BNE	1052492.5		9360.96		2860.812	1918.786	3123.482
BNE	1052626		9360.65		2863.053	1921.409	3123.5
BNE	1052752.5		9360.25		2865.412	1924.093	3123.516
BNE	1053092.5		9358.75		2870.604	1929.93	3123.609
BNE	1053355		9357.56		2878.502	1938.664	3123.792
BNE	1053642.5		9359.00		2886.458	1947.112	3124.019
BNE	1054270		9363.17		2901.048	1962.208	3124.438
BNE	1054660		9366.51		2916.077	1985.751	3124.845
BNE	1054825		9367.79		2922.658	1994.9	3124.992
BNE	1055125		9369.55		2931.115	2006.355	3125.175
BNE	1055350		9370.81		2937.25	2014.366	3125.307

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BNE	1055690		9372.78		2947.392	2027.41	3125.521
BNE	1056180		9377.15		2963.69	2046.939	3131.745
BNE	1056547.5		9379.52		2974.245	2058.424	3135.215
BNE	1056780		9381.15		2980.466	2064.792	3136.981
BNE	1056920		9382.68		2988.907	2073.417	3139.216
BNE	1057020		9383.80		2994.98	2079.581	3140.854
BNE	1057310		9385.69		3003.249	2087.897	3143.102
BNE	1057785		9388.51		3016.434	2100.51	3146.461
BNE	1058135		9390.76		3026.426	2109.529	3148.76
BNE	1058380		9392.39		3033.922	2116.178	3156.166
BNE	1058632.5		9393.87		3039.498	2121.142	3157.280
BNE	1058885		9395.76		3046.156	2127.15	3158.602
BNE	1059287.5		9398.13		3054.04	2144.593	3159.992
BNE	1059765		9402.58		3071.723	2176.923	3162.311
BNE	1060167.5		9407.17		3091.219	2204.757	3164.127
BNE	1060440		9409.09		3100.054	2216.361	3166.470
BNE	1060775		9411.28		3109.704	2228.434	3172.464
BNE	1061272.5		9416.57		3138.117	2240.76	3179.573
BNE	1061775		9420.98		3164.376	2268.078	3185.893
BNE	1062277.5		9426.36		3195.762	2289.007	3192.072
BNE	1062737.5		9433.81		3236.11	2313.651	3197.643
BNE	1063032.5		9439.68		3265.571	2330.904	3202.277
BNE	1063217.5		9502.84		3360.38	2821.58	3589.828
BNE	1063477.5		9506.97		3380.601	2800.929	3503.771
BNE	1063822.5		9511.48		3400.383	2800.043	3587.775
BNE	1064245		9517.65		3423.536	2817.639	3592.597
BNE	1064750		9526.25		3447.319	2824.439	3592.808
BNE	1065256.5		9535.97		3474.661	2831.375	3593.968
BNE	1065746.5		9545.29		3516.39	2865.258	3605.58
BNE	1066247.5		9556.66		3568.865	2908.046	3621.364
BNE	1066762.5		9568.75		3615.084	2944.885	3635.692
BNE	1067252.5		9581.60		3668.276	2984.478	3680.672
BNE	1067725		9597.30		3719.903	3020.169	3693.989
BNE	1068312.5		9611.68		3771.652	3061.497	3703.156
BNE	1068852.5		9624.40		3814.576	3115.522	3701.902
BNE	1069290		9634.52		3845.626	3153.327	3695.757
BNE	1069780		9647.56		3878.497	3193.543	3681.064
BNE	1070277.5		9660.53		3907.203	3230.048	3678.634
BNE	1070785		9675.14		3933.601	3265.48	3693.374
BNE	1071280		9690.78		3984.769	3299.853	3732.127
BNE	1071767.5		9705.64		4031.444	3330.04	3747.114
BNE	1072017.5		9714.36		4058.362	3346.708	3755.07
BNE	1072267.5		9852.49		4495	3999.283	4226.162
BNE	1072765		9869.31		4538.046	4033.744	4244.652
BNE	1073240		9887.07		4578.978	4069.634	4260.535
BNE	1073742.5		9906.60		4615.566	4106.86	4273.31
BNE	1074230		9926.21		4640.998	4141.543	4281.79
BNE	1074722.5		9946.61		4656.064	4174.602	4288.706
BNE	1075232.5		9969.27		4658.678	4206.114	4296.375
BNE	1075740		10005.78		4687.746	4249.857	4309.646
BNE	1076247.5		10055.11		4797.878	4304.698	4327.21
BNE	1076752.5		10097.50		4900.015	4347.834	4339.53
BNE	1077260		10162.60		5045.102	4431.304	4352.98
BNE	1077775		10209.14		5141.822	4495.167	4359.931
BNE	1078282.5		10245.22		5211.527	4541.907	4363.397
BNE	1078592.5		10259.43		5235.709	4558.495	4363.826
BREM	1000350		3546.66		1410.839	679.24	1697.693
BREM	1000910		3543.38		1407.527	677.225	1694.402
BREM	1001410		3539.52		1403.638	674.74	1690.399
BREM	1002000		3535.95		1401.86	673.859	1688.69
BREM	1002500		3539.62		1405.783	673.982	1691.89
BREM	1002915		3537.06		1404.837	673.783	1690.611
BREM	1003165	Perry Street	3306.44		1404.058	673.528	1689.454
BREM	1003450		3301.12		1403.134	673.154	1688.395

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BREM	1003770		3296.09		1401.681	671.397	1686.852
BREM	1003995		2164.23		1401.036	672.138	1685.802
BREM	1004235		2158.98		1400.416	673.782	1684.791
BREM	1004455		1604.99		1399.955	676.681	1642.632
BREM	1004600	One Mile Bridge	1604.77		1399.763	678.457	1641.818
BREM	1004630		1604.73		1399.714	678.119	1641.629
BREM	1004675		3513.24		1452.528	701.422	1714.887
BREM	1004920		3511.14		1451.15	699.107	1713.306
BREM	1005330		3509.58		1449.822	697.019	1712.017
BREM	1005630		3508.74		1449.170	696.233	1711.404
BREM	1005915		3513.25		1448.356	695.324	1710.33
BREM	1006170		3511.86		1447.944	695.19	1709.802
BREM	1006370		3508.31		1447.332	694.891	1709.059
BREM	1006500		3541.45		1447.054	694.703	1708.722
BREM	1006645		3518.41		1449.613	694.795	1710.582
BREM	1007110		3508.17		1447.82	693.617	1708.556
BREM	1007570		3507.05		1446.991	692.587	1707.816
BREM	1007850		3501.82		1448.283	692.455	1707.158
BREM	1008195		3487.07		1461.027	696.991	1714.069
BREM	1008400	Hancock Bridge	3485.59		1460.333	697.039	1713.081
BREM	1008415		3485.49		1460.263	696.624	1713.013
BREM	1008540		3484.67		1459.908	696.758	1712.548
BREM	1008935		3483.87		1459.243	695.342	1712.251
BREM	1009397.5		3480.91		1457.315	693.541	1710.068
BREM	1009630		3080.72		1450.27	692.584	1709.036
BREM	1009747.5		3079.25		1455.74	692.106	1708.609
BREM	1009920		3467.40		1455.201	691.812	1709.417
BREM	1010150		3466.61		1454.353	691.279	1708.703
BREM	1010490		3463.99		1452.452	690.497	1706.878
BREM	1010795		3461.34		1451.058	689.674	1705.759
BREM	1011105		3459.74		1449.905	688.698	1704.698
BREM	1011510		3461.67		1450.438	687.331	1708.638
BREM	1011745		3459.25		1449.529	686.697	1705.828
BREM	1011800		3458.95		1449.305	686.536	1705.628
BREM	1011930		3458.23		1446.760	686.176	1705.151
BREM	1012060	Marden Pde/ David Trumpy	3457.02		1447.958	685.701	1704.44
BREM	1012135		3456.33		1447.492	685.431	1704.048
BREM	1012535		3451.87		1445.294	684.217	1702.266
BREM	1013125		3446.15		1440.439	680.709	1698.499
BREM	1013540		3440.71		1437.597	678.84	1696.346
BREM	1013950		3433.14		1434.012	676.76	1693.977
BREM	1014430		3427.60		1431.772	675.439	1692.472
BREM	1014910		3423.47		1429.465	674.057	1690.973
BREM	1015312.5		3419.08		1427.677	673.045	1689.793
BREM	1016577.5		3414.92		1425.708	672.27	1688.632
BREM	1015910		3412.99		1425.51	671.383	1690.222
BREM	1016310		3323.59		1422.471	670.059	1688.293
BREM	1016795		3313.67		1419.242	668.907	1686.359
BREM	1017415		3307.20		1415.458	667.159	1684.811
BREM	1017945		3299.02		1410.193	665.97	1682.476
BREM	1018230		3295.26		1407.511	665.631	1681.709
BREM	1018410		3376.46		1406.172	665.235	1681.354
BREM	1018565		3374.38		1405.286	665.027	1681.109
BREM	1018595		3371.36		1404.622	664.881	1680.913
BREM	1018955		3362.92		1403.424	664.595	1680.585
BREM	1019365		3350.48		1400.259	663.935	1679.65
BREM	1019790		3331.63		1398.251	663.676	1678.703
BREM	1020150		3317.27		1395.953	663.58	1678.102
BREM	1020370		3242.14		1581.157	808.971	1888.159
BREM	1020445		3177.18		1580.016	808.014	1887.177
BREM	1020475		3062.61		1555.874	792.142	1867.523
BREM	1020710		3090.59		1553.693	790.797	1866.143
BREM	1021190		3070.64		1550.747	789.615	1863.235
BREM	1021880		3045.63		1554.89	789.195	1866.629

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BREM	1022625		3012.91		1550.085	787.407	1803.083
BREM	1023220		2986.25		1543.954	785.362	1859.931
BREM	1023500		2983.37		1542.876	784.7	1859.424
BREM	1023690		2981.63		1542.153	784.248	1859.095
BREM	1024045		2970.09		1540.294	783.112	1858.241
BREM	1024370		2960.99		1538.744	782.27	1857.558
BREM	1024635		2953.50		1537.081	781.453	1856.75
BREM	1025025		2947.28		1534.498	780.296	1855.611
BREM	1025485		2939.19		1531.793	778.875	1854.491
BREM	1025795		2935.58		1529.76	777.992	1853.54
BREM	1026035		2932.14		1528.49	777.4	1852.984
BREM	1026355		2927.01		1526.305	776.538	1852.084
BREM	1026630		2926.84		1535.601	777.853	1859.191
BREM	1027370		2915.18		1532.229	776.496	1857.715
BREM	1027740		2909.49		1529.761	775.676	1856.696
BREM	1028015		2904.02		1528	775.078	1855.966
BREM	1028340		2560.18		1525.817	774.355	1855.05
OXLEY	599700		1098.18		382.733	329.908	445.818
BREAKFAST	599700		1650.09		132.625	2253.95	1961.592
BULIMBA	599700		813.95		780.851	694.756	816.987
GOODNALINK1	500		272.27		0	0	0
GOODNALINK2	535		117.28		0	0	0
STLUCIALINK1	525		194.51		0	0	0
STLUCIALINK2	525		236.67		0	0	0
STLUCIALINK3	425		126.08		0	0	0
SIX	9662.5		73.65		22.982	16.174	37.303
SIX	9927.5		73.54		23.032	16.097	37.168
SIX	10185		73.59		23.041	16.058	37.102
SIX	10337.5		73.56		22.897	16.012	37.011
SIX	10377		73.55		22.925	16.028	36.989
SIX	10420		73.54		22.915	16.036	36.969
SIX	10690		73.46		22.878	16.048	37.071
SIX	11137.5		77.34		23.868	16.791	38.092
SIX	11462.5		89.90		27.522	19.325	41.6
SIX	11620		113.03		33.624	24.591	47.578
SIX	11720		112.98		33.488	24.378	47.592
SIX	11785		113.00		33.286	24.248	47.6
SIX	11835		113.03		33.247	24.241	47.597
SIX	11940		113.07		33.264	24.228	47.584
SIX	12240		112.92		33.398	24.246	47.622
SIX	12720		126.26		36.648	27.374	50.818
SIX	13132.5		146.83		43.024	31.257	55.720
SIX	13457.5		146.69		42.072	30.957	55.469
SIX	13832.5		146.71		39.019	30.339	55.509
SIX	14257.5		146.45		39.059	30.328	55.492
SIX	14635		144.70		38.155	29.983	53.119
SIX	14985		149.60		38.462	30.452	55.351
SIX	15370		164.47		39.35	31.164	60.779
SIX	15740		164.22		39.224	30.702	60.357
SIX	16090		172.02		39.432	30.919	64.278
SIX	16370		172.04		39.428	30.892	64.277
SIX	16595		181.23		40.108	31.337	68.943
SIX	16930		185.94		42.432	31.483	71.489
SIX	17205		185.87		42.48	31.434	71.477
SIX	17400		188.86		43.875	31.499	73.014
SIX	17730		188.88		43.864	31.606	73.002
SIX	18100		188.69		43.76	31.484	72.909
SIX	18495		193.04		45.829	31.631	75.197
SIX	18845		188.22		45.769	31.631	75.193
SIX	19070		186.54		45.783	31.633	75.171
SIX	19270		192.96		50.387	31.912	80.053
SIX	19510		190.88		50.274	31.924	79.845
SIX	19720		189.13		50.054	31.83	79.378
SIX	19850		194.57		52.887	31.892	82.076

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m³/s)	Dec 1991 PREDICTED FLOW (m³/s)	Jun 1993 PREDICTED FLOW (m³/s)	Apr 1989 PREDICTED FLOW (m³/s)	May 1996 PREDICTED FLOW (m³/s)
SIX	19935		193.96		52.771	31.825	81.659
SIX	20070		193.12		52.477	31.545	81.448
SIX	20150		196.51		54.287	31.543	83.186
SIX	20197.5		196.24		54.168	31.46	83.055
GOOD	10137.5		51.93		17.16	6.535	21.257
GOOD	10375		51.89		16.951	4.907	21.095
GOOD	10590		51.87		16.955	4.887	21.183
GOOD	10815		51.81		16.706	4.88	21.133
GOOD	11130		61.55		20.876	6.452	25.805
GOOD	11480		61.49		20.328	6.266	25.584
GOOD	11785		61.49		19.972	6.253	25.362
GOOD	11982.5		65.85		21.412	6.809	26.819
GOOD	12032		65.85		21.401	6.864	26.784
GOOD	12099.5		65.84		21.403	6.86	26.793
GOOD	12290		85.04		28.01	9.442	34.619
GOOD	12552.6		85.03		20.107	9.479	34.602
GOOD	12807.5		84.96		27.824	9.339	34.545
GOOD	13105		97.56		31.224	10.225	39.278
GOOD	13376		97.48		30.789	10.137	39.162
GOOD	13575		97.45		30.676	10.08	39.078
GOOD	13915		97.53		30.657	12.43	39.136
GOOD	14175		102.50		31.611	4.758	41.332
GOOD	14235		101.59		31.34	9.802	41.105
GOOD	14320		100.28		30.928	10.492	40.862
GOOD	14465		98.66		30.449	10.424	40.676
GOOD	14565		97.69		30.331	10.415	40.54
GOOD	14595		97.32		30.343	10.413	40.536
GOOD	14625		96.88		30.329	10.412	40.462
GOOD	14685		95.98		30.295	10.411	40.289
GOOD	14815		94.32		30.009	10.38	39.98
GOOD	14900		98.71		30.661	10.679	41.252
GOOD	14913		98.52		30.657	10.678	41.262
GOOD	14925		98.33		30.651	10.677	41.257
GOOD	14952.5		97.69		30.638	10.674	41.246
GOOD	15162.5		93.97		30.512	10.627	41.136
GOOD	15597.5		109.46		30.226	10.496	40.731
GOOD	16010		124.34		30.041	10.403	40.229
GOOD	16265		129.25		29.787	10.374	39.842
GOOD	16440		130.75		29.556	10.342	39.55
GOOD	16625		132.91		29.146	10.283	39.106
SAND	10160		37.59		13.109	4.239	19.533
SAND	10420		37.64		13.029	4.205	19.44
SAND	10720		41.52		14.342	4.62	21.25
SAND	10980		44.12		15.125	4.898	21.954
SAND	11051		44.11		15.12	4.9	21.955
SAND	11151		44.10		15.119	4.903	21.966
SAND	11379		44.09		15.106	4.887	21.95
SAND	11529		47.16		16.027	5.202	23.452
SAND	11650		47.17		16.015	5.203	22.855
SAND	11879		53.12		17.979	5.869	24.489
SAND	12002		53.10		17.977	6.56	24.498
SAND	12070		54.99		18.571	26.004	25.046
SAND	12280		54.94		18.555	7.566	25.026
SAND	12565		54.94		18.497	7.501	24.978
SAND	12655		60.23		20.352	7.98	26.512
SAND	13170		60.25		20.347	7.995	26.533
SAND	13570		63.10		21.255	7.909	27.309
SAND	14020		75.61		25.721	9.622	33.418
SAND	14420		75.56		25.49	8.893	33.35
SAND	14660		86.68		29.07	9.865	38.103
SAND	14720		86.67		29.071	9.859	38.076
SAND	14780		86.67		29.071	9.849	38.075
SAND	15068.89		86.66		29.068	9.859	38.096
SAND	15566.67		86.67		29.039	10.253	38.039

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
SAND	16064.45		86.66		28.978	10.205	37.964
SAND	16552.22		86.66		28.962	10.08	37.971
SAND	17060		86.66		28.937	9.922	37.931
SAND	17557.78		86.66		28.916	9.829	37.929
SAND	18055.56		86.61		28.673	9.791	37.881
SAND	18553.34		84.69		28.927	9.762	37.913
SAND	19051.11		81.54		28.33	9.723	37.098
WOOG	10225		451.31		125.27	34.776	169.194
WOOG	10690		451.04		124.654	34.622	168.625
WOOG	11040		450.93		124.573	34.628	168.295
WOOG	11340		450.75		124.207	34.6	168.237
WOOG	11780		450.53		124.164	34.528	168.033
WOOG	12080		450.21		123.358	34.359	167.387
WOOG	12375		450.46		123.347	34.328	167.069
WOOG	12775		480.91		128.404	35.07	176.112
WOOG	13000		480.51		128.376	35.022	175.845
WOOG	13160		483.21		128.506	35.021	176.927
WOOG	13380		482.93		128.258	35.011	176.643
WOOG	13530		482.73		128.121	34.968	176.398
WOOG	13595		482.65		128.093	34.955	176.3
WOOG	13705		482.40		128.014	34.955	176.005
WOOG	13765		482.26		127.929	34.95	175.868
WOOG	13930		482.06		127.81	34.939	175.879
WOOG	14035		481.93		127.773	34.928	175.876
WOOG	14085		481.90		127.777	34.925	175.873
WOOG	14140		481.91		127.779	34.910	175.871
WOOG	14315		481.97		127.778	34.890	175.854
WOOG	14620		481.96		127.718	34.902	175.736
WOOG	14620		481.94		127.6	34.894	175.476
WOOG	14880		481.94		127.582	34.895	175.47
WOOG	14920		481.93		127.55	34.881	175.457
WOOG	14940		481.93		127.665	34.931	175.451
WOOG	14980		488.90		128.074	35.011	179.617
WOOG	15017.5		488.69		128.031	35.212	179.603
WOOG	15037.5		488.88		128.015	35.371	179.597
WOOG	15085		489.88		128.016	35.375	179.588
WOOG	15135		488.86		128.015	35.86	179.568
WOOG	15190		488.63		128.012	36.622	179.54
WOOG	15265		488.78		128.007	43.043	179.519
WOOG	15335		488.72		127.995	52.593	179.479
WOOG	15420		488.60		127.964	35.972	179.401
WOOG	15495		488.48		127.94	35.085	179.344
WOOG	15560		488.24		127.918	35.049	179.251
WOOG	15660		487.80		127.887	35.106	179.139
WOOG	15760	Parker Street	486.34		127.686	35.13	178.73
WOOG	15820		488.65		127.822	35.161	180.796
WOOG	15850	Edna Street	488.32		127.818	35.16	180.681
WOOG	15910		487.61		127.768	35.158	180.2
WOOG	15976		486.84		127.756	35.151	180.128
WOOG	16000		486.61		127.749	35.147	180.088
WOOG	16067.5		485.55		127.654	35.129	179.796
WOOG	16137.5		484.57		127.64	35.122	179.775
WOOG	16212.5		484.41		127.614	35.109	179.735
WOOG	16357.5		484.26		127.578	35.093	179.673
WOOG	16520		482.03		127.546	35.065	179.381
WOOG	16550		480.12		127.539	35.059	179.178
WOOG	16775		478.32		127.527	35.053	178.868
WOOG	16875		476.08		127.537	35.06	178.80
WOOG	16975		475.63		127.557	35.068	178.836
WOOG	17087.5	Brisbane Road	475.66		127.590	35.092	178.777
WOOG	17200		476.50		127.92	35.094	179.079
WOOG	17292.5		474.40		128.105	36.163	178.944
WOOG	17340		503.84		130.46	37.962	191.696
WOOG	17405		518.39		131.859	42.332	194.18

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
WOOG	17450		577.87		139.584	56.809	206.393
WOOG	17480		499.91		130.326	40.09	191.284
WOOG	17525		487.31		127.763	35.507	187.193
WOOG	17565		482.25		127.556	34.844	186.762
WOOG	17590	Brisbane Terrace	480.18		127.414	34.411	186.601
WOOG	17607.5		480.25		127.431	34.47	186.615
WOOG	17682.5		479.20		127.892	34.927	187.417
WOOG	17755		479.65		128.155	34.981	187.434
WOOG	17770		482.05		128.176	34.981	187.416
WOOG	17865		476.04		127.766	35.016	186.701
WOOG	17955		474.40		127.773	35.002	186.661
WOOG	18105		472.15		127.694	34.888	186.419
WOOG	18375		471.09		127.46	34.483	186.302
WOOG	18625		469.62		127.161	34.013	186.143
WOOG	18825		468.73		126.783	33.509	185.91
WOOG	18987.5		467.79		126.365	33.112	185.62
WAR	100249.5		2309.28		364.347	287.038	425.163
WAR	100736		2308.65		363.518	286.959	425.011
WAR	101128.5		2308.40		363.475	286.935	424.858
WAR	101439.5		2308.51		363.343	286.909	424.733
WAR	101734.5		2309.48		363.13	286.903	424.606
WAR	102013.5		2310.28		363.08	286.896	424.468
WAR	102305.5		2311.11		363.183	286.881	424.575
WAR	102613.5		2321.64		370.853	287.043	442.451
WAR	102958.25		2322.79		371.096	287.037	442.255
WAR	103340.75		2323.78		371.662	287.03	442.078
WAR	103681.5		2324.46		372.899	287.023	441.992
WAR	103980		2261.34		374.383	287.015	441.902
WAR	104208		2261.11		375.806	287.018	441.829
WAR	104365.5		2139.72		376.753	287.021	442.011
WAR	104624.5		2138.69		377.793	287.027	442.242
WAR	104985.5		2338.55		379.698	287.043	442.621
WAR	105309.5		2682.43		681.22	443.343	955.01
WAR	105629.5		2680.00		681.436	442.702	962.278
WAR	106054.5		2677.25		682.524	442.073	956.549
WAR	106433.5		2679.55		688.071	444.503	961.783
WAR	106739		2677.24		689.541	443.812	959.091
WAR	107014		2675.81		690.409	443.193	955.988
WAR	107260		3145.41		691.246	442.734	954.101
WAR	107449		3145.03		691.683	442.537	953.05
WAR	107573		4935.90		1159.944	468.455	1547.470
WAR	107697		3144.64		692.773	441.936	950.504
WAR	107896		3144.35		691.094	441.306	947.487
WAR	108105		2672.63		695.771	440.594	943.767
PURGA	100216		828.42		364.985	242.331	574.976
PURGA	100602.5		819.25		363.941	240.848	573.628
PURGA	100943		511.97		363.312	239.789	572.145
PURGA	101296		503.66		362.678	238.785	570.315
PURGA	101662		557.66		364.216	240.286	572.809
PURGA	102009.5		552.74		363.695	239.47	570.345
PURGA	102338		354.57		363.08	238.406	568.525
WARLINK	150		12.54		42.511	44.158	50.746
FP1WAR	120		0.00		0	0	0
PWLINK1	0.5		300.81		0	0	0
PWLINK3	0.5		203.05		0	0	0
PWLINK2	0.5		68.72		0	0	0
BREMBRISLINK1	75		281.95		0	0	0
BREMLINKBRANCH1	5		80.12		0	0	0
BREMLINKBRANCH2	25		328.76		0	0	0
BUND	10153.75		127.67	101.476	49.585	61.969	84.668
BUND	10461.25		127.61	101.504	49.416	61.632	84.724
BUND	10861.25		127.49	101.484	49.197	61.750	84.769
BUND	11353.75		127.18	101.298	49.186	61.337	84.568
BUND	11784.17		166.90	135.05	64.79	80.332	112.55

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m³/s)	Dec 1991 PREDICTED FLOW (m³/s)	Jun 1993 PREDICTED FLOW (m³/s)	Apr 1989 PREDICTED FLOW (m³/s)	May 1996 PREDICTED FLOW (m³/s)
BUND	12152.5		167.05	135.123	64.777	80.372	112.578
BUND	12520.83		166.78	135.081	64.666	80.272	112.585
BUND	12935		166.71	134.872	64.61	80.082	112.499
BUND	13358.75		166.72	134.853	64.624	80.135	112.421
BUND	13746.25		166.64	134.904	64.588	80.127	112.443
BUND	14076.75		166.58	134.893	64.48	80.046	112.403
BUND	14356.25		166.61	134.841	64.447	79.939	112.456
BUND	14635		166.67	134.813	64.485	79.928	112.449
BUND	14915		165.72	134.751	64.549	80.016	112.435
BUND	15216.25		162.96	133.463	64.363	79.512	111.869
BUND	15538.75		162.51	132.546	64.338	79.531	111.84
BUND	15873.75		285.70	224.52	109.57	129.789	189.89
BUND	16221.25		285.58	224.248	109.647	129.719	189.732
BUND	16521.25	Ripley (16395)	285.55	224.23	109.428	129.499	189.532
BUND	16773.75		285.49	224.189	109.298	129.396	189.538
BUND	17057.5		285.34	224.117	109.335	129.415	189.51
BUND	17372.5		285.30	223.868	109.331	129.371	189.448
BUND	17707.5		285.23	223.923	109.268	129.228	189.376
BUND	18096.25		285.16	223.934	109.187	129.074	189.353
BUND	18518.75		285.13	223.873	107.41	128.928	189.137
BUND	18740		301.87	224.494	106.203	143.159	188.922
BUND	18682.5		285.70	223.692	111.416	128.724	188.938
BUND	19147.5		284.81	223.582	109.918	128.637	188.957
BUND	19410		284.75	223.545	109.711	128.686	188.954
BUND	19670		284.62	223.430	109.423	128.703	188.844
BUND	19960		284.48	223.416	109.382	128.626	188.629
BUND	20280		284.47	223.428	109.424	128.471	188.673
BUND	20672.5		345.68	273.81	133.695	140.920	207.655
BUND	21137.5		345.42	272.877	133.348	146.531	207.162
BUND	21548.75		245.18	271.93	133.335	146.521	207.056
BUND	21906.25		344.42	271.711	133.112	146.429	206.553
BUND	22102.5		406.15	321.857	156.581	171.705	246.354
BUND	22286.25		405.52	321.49	156.401	171.481	245.789
BUND	22618.75		404.60	320.914	156.146	170.851	244.582
BUND	22967.5		404.09	320.535	155.951	170.48	243.538
BUND	23332.5		403.54	320.157	155.742	170.105	243.065
BUND	23668.75		403.18	320.007	155.518	169.727	242.76
BUND	23976.25		403.14	319.884	155.506	169.634	242.702
BUND	24287.5		403.10	319.909	155.508	169.546	242.637
BUND	24602.5		403.04	319.956	155.492	169.491	242.545
BUND	24917.5		436.28	344.338	165.835	175.36	251.112
BUND	25201.25		436.18	344.274	165.774	175.226	251.021
BUND	25453.75		436.13	344.071	165.672	175.174	250.08
BUND	25590		436.08	344.029	165.689	175.108	240.842
BUND	25835		435.98	344.021	165.684	174.964	251.412
BUND	26305		473.68	370.25	176.842	177.272	259.695
BUND	26660		473.45	369.922	176.728	176.808	259.39
BUND	27030		492.65	384.393	183.165	177.64	264.822
BUND	27330		492.55	384.185	183.008	177.173	264.475
BUND	27390		492.53	384.174	182.980	177.342	264.404
BUND	27527.5		492.57	384.077	183.087	177.028	264.433
BUND	27665		492.48	383.028	183.079	177.049	264.408
BUND	27842.5		492.45	383.757	183.064	177.044	264.365
BUND	28105		492.41	383.272	182.955	176.618	263.889
BUND	28320		362.74	338.979	182.863	176.509	253.136
BUND	28450		362.67	338.929	182.842	176.437	253.066
BUND	28470		362.65	338.932	182.839	176.425	253.055
BUND	28510		362.63	338.037	182.833	176.402	253.034
BUND	28535		362.61	338.922	162.831	176.387	253.012
BUND	28550		362.59	338.907	182.83	176.377	252.995
BUND	28730		506.94	390.576	186.964	177.298	266.656
BUND	29070	Harding Street (29240)	506.64	390.147	186.909	177.063	266.306
BUND	29395		506.58	389.654	186.853	176.892	266.026
BUND	29730		506.49	389.771	186.925	176.728	265.84

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m^3/s)	Dec 1991 PREDICTED FLOW (m^3/s)	Jun 1993 PREDICTED FLOW (m^3/s)	Apr 1989 PREDICTED FLOW (m^3/s)	May 1996 PREDICTED FLOW (m^3/s)
BUND	30062.5		546.96	410.805	199.567	178.056	273.572
BUND	30367.5		546.28	409.814	199.478	177.934	273.131
BUND	30730		545.26	408.598	199.256	177.535	272.638
BUND	31150		544.30	406.66	198.982	177.079	271.536
BUND	31495		543.91	405.71	198.655	176.495	270.754
BUND	31805		543.68	405.19	196.51	176.151	270.423
BUND	31990	Blackstone Road	543.56	404.874	198.361	176.008	270.195
BUND	32075		543.53	404.794	198.353	175.984	270.151
BUND	32250		543.50	404.715	198.341	175.907	270.107
BUND	32360		543.41	401.472	198.309	175.802	269.997
BUND	32522.5		543.26	404.182	198.262	175.714	269.634
BUND	32827.5		543.22	404.099	198.242	175.678	269.738
BUND	33150		543.21	404.065	198.211	175.59	269.576
BUND	33490		543.21	403.988	198.129	175.381	269.249
BUND	33805		543.30	403.41	198.026	174.971	267.883
BUND	33975		552.21	406.15	200.643	174.731	268.355
BUND	34130		552.30	406.134	200.658	174.629	268.069
BUND	34282.5	Brisbane Road	569.99	409.835	204.601	174.421	271.945
BUND	34325		569.82	409.796	204.692	174.351	271.821
BUND	34370		569.70	409.728	204.596	174.364	271.838
BUND	34577.5		569.67	409.687	204.6	174.372	271.847
BUND	34906		567.56	409.078	204.519	174.185	271.667
BUND	35075		566.96	408.954	204.524	174.147	271.598
BUND	35110		566.67	408.898	204.527	174.124	271.569
BUND	35320		564.48	408.613	204.538	174.131	271.579
BUND	35530		577.24	411.002	207.278	174.166	274.797
BUND	35635		576.76	410.983	207.266	174.156	274.796
BUND	35867.5		573.09	410.885	207.214	174.114	274.762
BUND	36015	Gledson Street	569.69	410.833	207.029	174.014	274.646
BUND	36161.25		566.23	410.462	206.991	173.959	274.528
BUND	36433.75		559.53	410.221	206.885	173.958	274.305
BUND	36705		552.20	410.203	206.84	173.942	274.194
BUND	36975		542.88	409.99	206.63	173.802	273.639
BUND	37285		529.69	409.517	206.102	173.66	272.43
BUND	37635		517.19	408.966	205.428	173.412	270.978
BUND	37860		507.47	408.49	204.407	173.267	269.887
BUND	38095		501.43	408.204	203.683	173.243	268.515
BUND	38501.25		486.69	407.285	201.314	172.877	264.683
BUND	38943.75		470.44	405.45	198.038	172.266	260.336
BUND	39355.63		458.59	404.159	197.639	171.591	258.403
BUND	39737.5		437.79	399.528	196.296	170.533	255.252
BUND	40119.17		413.81	393.513	195.079	169.175	251.835
BUND	40490		386.91	386.593	193.803	167.607	248.301
BUND	40850		370.37	380.232	192.712	166.175	244.921
HWAY	#VALUE!		21.97	18.133	14.733	13.696	13.743
HWAY	#VALUE!		20.50	17.872	7.617	7.214	7.314
HWAY	#VALUE!		144.35	52.068	7.194	6.854	13.73
HWAY	#VALUE!		144.32	51.988	7.147	6.834	13.711
HWAY	#VALUE!		144.32	51.977	7.13	6.785	13.71
HWAY	#VALUE!		144.32	51.973	7.097	6.658	13.726
LOW	#VALUE!		13.89	31.421	11.177	5.693	7.518
LOW	#VALUE!		11.07	30.609	10.337	7.342	7.398
LOW	#VALUE!		15.27	15.494	5.667	4.813	5.309
LOW	#VALUE!		24.20	15.407	6.542	3.202	3.895
UP	#VALUE!		74.24	63.056	29.351	35.249	51.61
UP	#VALUE!		74.03	62.931	29.152	35.246	51.50
UP	#VALUE!		74.17	62.762	29.221	35.088	51.428
UP	#VALUE!		73.72	62.915	29.235	35.809	51.622
UP	#VALUE!		67.88	53.78	27.11	30.455	46.455
BUND#	45		0.00	0	0	0	0
REEDY	1132.25		27.39		13.247	13.724	10.2
REEDY	1396.75		27.26		12.965	13.516	10.101
REEDY	1535.5		27.13		12.834	13.429	10.075
REEDY	1745		26.88		12.654	13.456	10.01

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m³/s)	Dec 1991 PREDICTED FLOW (m³/s)	Jun 1993 PREDICTED FLOW (m³/s)	Apr 1989 PREDICTED FLOW (m³/s)	May 1996 PREDICTED FLOW (m³/s)
REEDY	2043.5		0.19		0.183	0.182	0.183
SMALL	1114		18.77		9.834	9.62	7.066
SMALL	1242.5		18.69		9.671	9.578	7.022
SMALL	1333		18.65		9.592	9.558	7.002
SMALL	1516.5		18.06		9.511	9.528	6.967
SMALL	1647		28.67		9.606	9.502	7
SMALL	1779		32.15		14.936	14.759	10.934
SMALL	1939		27.37		14.729	14.527	10.698
SMALL	2059		65.48		14.499	14.359	10.477
DEEB	10157.5		71.96		30.127	35.023	25.195
DEEB	10451.75		71.91		29.882	34.897	25.164
DEEB	10725.25		71.86		29.936	34.97	25.148
DEEB	11001.5		71.80		29.93	34.879	25.106
DEEB	11297		71.86		29.544	34.592	25.056
DEEB	11645		71.79		29.163	34.263	24.928
DEEB	11974		71.74		29.15	34.174	24.873
DEEB	12244		71.76		29.117	34.146	24.892
DEEB	12510		71.76		29.042	34.172	24.891
DEEB	12785		97.15		38.477	45.482	33.233
DEEB	12937		97.16		38.488	45.463	33.238
DEEB	13056		97.17		38.602	45.454	33.249
DEEB	13230		97.10		41.402	58.242	43.703
DEEB	13441		104.30		39.073	48.057	35.132
DEEB	13737.5		104.26		39.945	48.024	35.09
DEEB	13905		104.23		39.943	48.028	35.097
DEEB	14061.5		104.21		39.935	48.027	35.097
DEEB	14343.5		104.19		39.825	47.949	35.019
DEEB	14628.5		111.63		42.243	51.511	37.463
DEEB	14875		110.48		42.221	51.48	37.391
DEEB	15069		118.22		44.562	55.413	40.423
DEEB	15247.5		116.51		44.58	55.387	40.407
DEEB	15509		110.56		44.419	55.155	40.287
DEEB	15687		107.03		44.447	55.172	40.315
DEEB	15798		104.66		44.464	55.175	40.316
DEEB	15969.5		102.30		44.528	55.255	40.539
DEEB	16116.5		134.18		64.809	77.136	60.758
DEEB	16206.5		133.48		64.982	77.267	60.925
DEEB	16259		133.11		64.985	77.258	60.924
DEEB	16321.5		136.50		66.497	79.074	62.198
DEEB	16474.5		134.88		66.473	79.036	62.128
DEEB	16622		127.05		66.421	79.069	61.928
DEEB	16639		126.52		66.417	79.073	61.901
DEEB	16748.5		123.19		68.41	79.1	61.729
DEEB	16907		120.28		66.395	79.128	61.493
DEEB	17012		75.99		68.362	79.191	61.027
DEEB	17072		76.11		65.323	79.262	60.572
DEEB	17078.5		127.85		76.825	91.264	68.824
DEEB	17198.5		124.03		76.551	91.145	69.273
DEEB	17463		110.46		75.312	90.822	65.6
DEEB	17619		103.55		75.136	90.807	64.2
DEEB	17663		335.84		74.193	90.803	64.199
DEEB	17708		335.86		74.195	90.799	64.198
DEEB	17809.5		335.95		74.199	90.731	64.168
DEEB	17923		336.04		74.201	90.64	64.132
DEEB	18132		336.22		74.271	90.527	64.311
DEEB	18347		337.74		75.4	93.677	67.358
DEEB	18417.5		337.78		74.415	93.624	68.006
DEEB	18491		337.80		74.833	93.642	68.661
DEEB	18547.5		337.63		76.145	93.635	69.163
DEEB	18631.5		1426.62		76.038	93.574	69.959
DEEB	18732.5		1426.39		80.324	93.392	70.948
DEEB	18865.5		1428.06		81.159	92.722	72.182
DEEB	19024		1425.72		79.758	92.036	73.42
DEEB	19122		1426.09		78.592	91.493	74.59

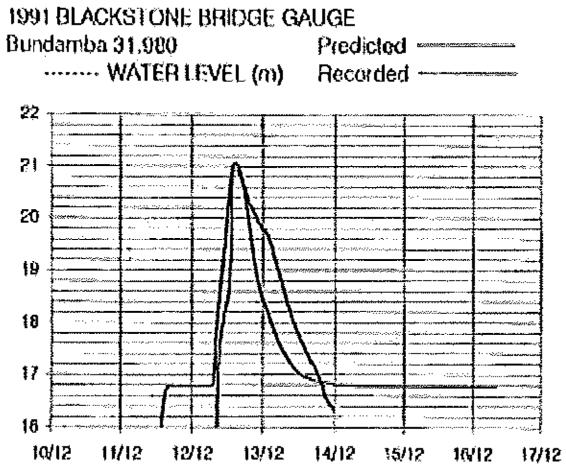
Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m³/s)	Dec 1991 PREDICTED FLOW (m³/s)	Jun 1993 PREDICTED FLOW (m³/s)	Apr 1989 PREDICTED FLOW (m³/s)	May 1996 PREDICTED FLOW (m³/s)
DEEB	19144.5		1425.90		78.36	91.355	74.877
DEEB	19202		1913.16		77.712	91.002	174.069
DEEB	19324		1912.80		76.013	90.183	174.404
DEEB	19469		1911.76		73.771	88.093	174.8
DEEB	19572		1912.35		74.169	69.383	177.166
DEEB	19654.6		1912.53		72.976	88.731	177.428
DEEB	19764.5		1912.94		71.858	87.261	177.618
DEEB	19837		1913.25		71.171	86.431	177.734
DEEB	19879.5		1913.45		70.735	85.942	177.811
DEEB	19962		1913.45		70.735	85.942	177.811
IRON_BR1	1164.5		2.76		1.092	0.869	1.509
IRON_BR1	1473.5		3.16		0.942	0.85	1.299
IRON_BR1	1735.5		9.91		0.095	0.088	0.084
IRON_BR1	1858		5.63		2.782	3.800	3.741
IRON_BR1	2022.5		5.73		3.017	3.358	4.115
IRON_BR1	2312.5		18.52		0.709	0.694	0.719
IRON_BR1	2477		10.48		4.949	4.045	7.201
IRON	10137		2.65		1.588	1.201	2.125
IRON	10418.5		2.65		1.587	1.22	2.122
IRON	10644		2.65		1.585	1.186	2.121
IRON	10863		3.51		2.073	1.048	1.483
IRON	11187.5		8.78		1.82	1.289	7.901
IRON	11398		15.23		7.93	6.374	11.28
IRON	11593.5		17.59		8.973	7.273	13.348
IRON	11779.5		17.56		8.774	7.101	13.344
IRON	11923		17.56		8.72	7.113	13.334
IRON	12193.5		43.52		19.829	17.908	33.639
IRON	12476.5		43.55		19.813	17.965	33.596
IRON	12641		43.56		19.83	17.951	33.626
IRON	12810.25		43.56		19.85	17.938	33.657
IRON	13114.75		43.46		19.074	17.836	33.47
IRON	13516.5		48.08		21.798	19.648	37.108
IRON	13936.5		47.99		21.570	19.562	36.959
IRON	14281.5		71.10		30.818	26.65	54.7
IRON	14630.5		71.05		30.801	28.814	54.6
IRON	14972		71.01		30.807	28.825	54.542
IRON	15273		70.88		29.879	28.678	54.264
IRON	15553.5		74.92		30.988	32.231	57.173
IRON	15793.5		74.24		30.98	131.444	57.209
IRON	16042.75		70.81		30.909	37.198	57.23
IRON	16354.25		62.48		30.913	35.937	57.12
IRON	16668.5		49.28		30.632	35.645	56.998
IRON	16960		48.27		32.386	37.097	62.543
IRON	17214.5		67.30		39.538	48.358	79.882
IRON	17482		62.11		38.445	48.05	76.174
IRON	17756		55.36		37.043	48.02	74.882
IRON	17957.5		52.60		35.941	47.793	73.102
IRON	18093.5		53.79		34.972	47.409	71.654
IRON	18209.5		54.57		33.832	46.796	69.852
IRON	18313		55.27		32.899	46.234	68.335
IRON	18375		58.03		32.573	45.94	67.386
IRON	18484		57.33		31.878	44.732	65.812
MIHI	10098		15.77		7.283	6.4	6.224
MIHI	10352.5		15.70		7.309	6.348	6.202
MIHI	10612		15.72		7.294	6.309	6.18
MIHI	10728		15.73		7.264	6.328	6.179
MIHI	10817		23.84		7.237	6.334	6.185
MIHI	10959.5		17.26		8.161	8.871	6.8
MIHI	11073.5		25.41		12.388	10.66	10.486
MIHI	11197		28.02		14.178	11.938	11.746
MIHI	11298		25.79		14.106	11.947	11.736
MIHI	11369		23.76		14.065	11.969	11.732
MIHI	11588		19.65		13.991	11.968	11.717
MIHI	11836		16.69		13.211	11.851	11.697

Table D-2 Predicted Discharges for Calibration Events (cont)

RIVER REACH	MIKE 11 CHAINAGE	STRUCTURE/ GAUGE	Jan 1974 PREDICTED FLOW (m³/s)	Dec 1991 PREDICTED FLOW (m³/s)	Jun 1993 PREDICTED FLOW (m³/s)	Apr 1989 PREDICTED FLOW (m³/s)	May 1996 PREDICTED FLOW (m³/s)
MHI	12051.5		20.42		15.902	14.548	14.453
MHI	12182.5		441.42		17.97	17.256	16.981
MHI	12357.5		440.87		16.862	17.197	16.715
MHI	12557.5		440.33		15.887	17.561	16.536
MHI	12697		439.89		14.941	16.629	16.007
MHI	12842.5		439.43		11.624	15.125	14.673
MHI	13020.5		438.91		14.762	13.888	13.469
MHI_BR1	1322		3.42		0.979	0.752	0.806
MHI_BR1	1382		1.70		0.967	0.749	0.802
MHI_BR1	1441.5		1.76		0.987	0.815	0.916
MHI_BR1	1649		1.95		0.966	0.744	0.801
MHI_BR1	1949.5		4.50		0.713	0.698	0.053
MHI_BR1	2209		9.63		4.11	3.594	3.628
MHI_BR1	2454.5		13.62		4.144	3.576	3.62
MHI_BR1	2580		8.75		4.144	3.56	3.614
MHI_BR1	2640.5		8.89		4.279	3.659	3.606
SCH	10170		24.05		10.732	9.704	9.459
SCH	10570		24.63		10.63	9.721	9.438
SCH	10805		24.63		10.581	9.739	9.44
SCH	10960		24.63		10.014	9.747	9.437
SCH	11246.4		46.85		19.641	18.461	17.655
SCH	11496.4		51.11		25.402	21.631	22.65
SCH	11748.6		73.64		5.635	3.481	5.007
SCH	11907		46.31		20.251	18.916	18.247
SCH	12047		47.46		20.847	19.508	18.621
SCH	12227		53.72		24.686	22.94	22.056
SCH	12361		50.84		24.603	22.979	22.036
SCH	12449		49.36		24.636	22.66	22.044
SCH	12634.2		46.24		24.577	26.073	22.054
SCH	12927.8		40.18		24.109	22.212	23.295
SCH	13055		58.27		24.468	23.53	23.256
SCH	13134.5		60.66		23.717	24.031	23.137
SCH	13403.75		68.33		23.681	24.071	22.872
SCH	13674.25		77.08		21.994	23.762	21.316
SCH	13753.5		105.63		21.559	23.618	20.965
SCH	13864.5		108.20		20.963	23.41	20.485
MHI_LINK1	15		0.00		0	0	0
SCH_LK1	15		0.00		0	0	0
DEEBING_LK1	15		676.21		0.002	0	137.712
DEEBING_LK2	15		1140.96		0	0	0
DEEBING_LK3	15		302.22		0	0	0
DEEBING_LK4	15		52.61		0	0	0.272
DEEBING_LK5	15		18.86		0	0	0
DEEBING_LK7	15		0.00		0	0	0
WOOG_LK1	15		0.00		0	0	0
WOOG_LK2	15		0.00		0	0	0
DEEBING_LK6	15		0.00		0	0	0
BREMBRIS2	71.09		474.57		0	0	0
SCH_LK2	30.83		0.00		0	0	0

Figure D-1 Predicted & Recorded Hydrograph Comparison - December 1991



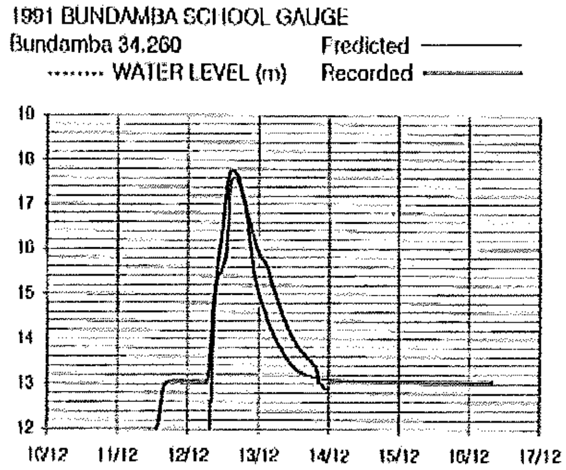


Figure D-2 Predicted & Recorded Hydrograph Comparison - January 1974

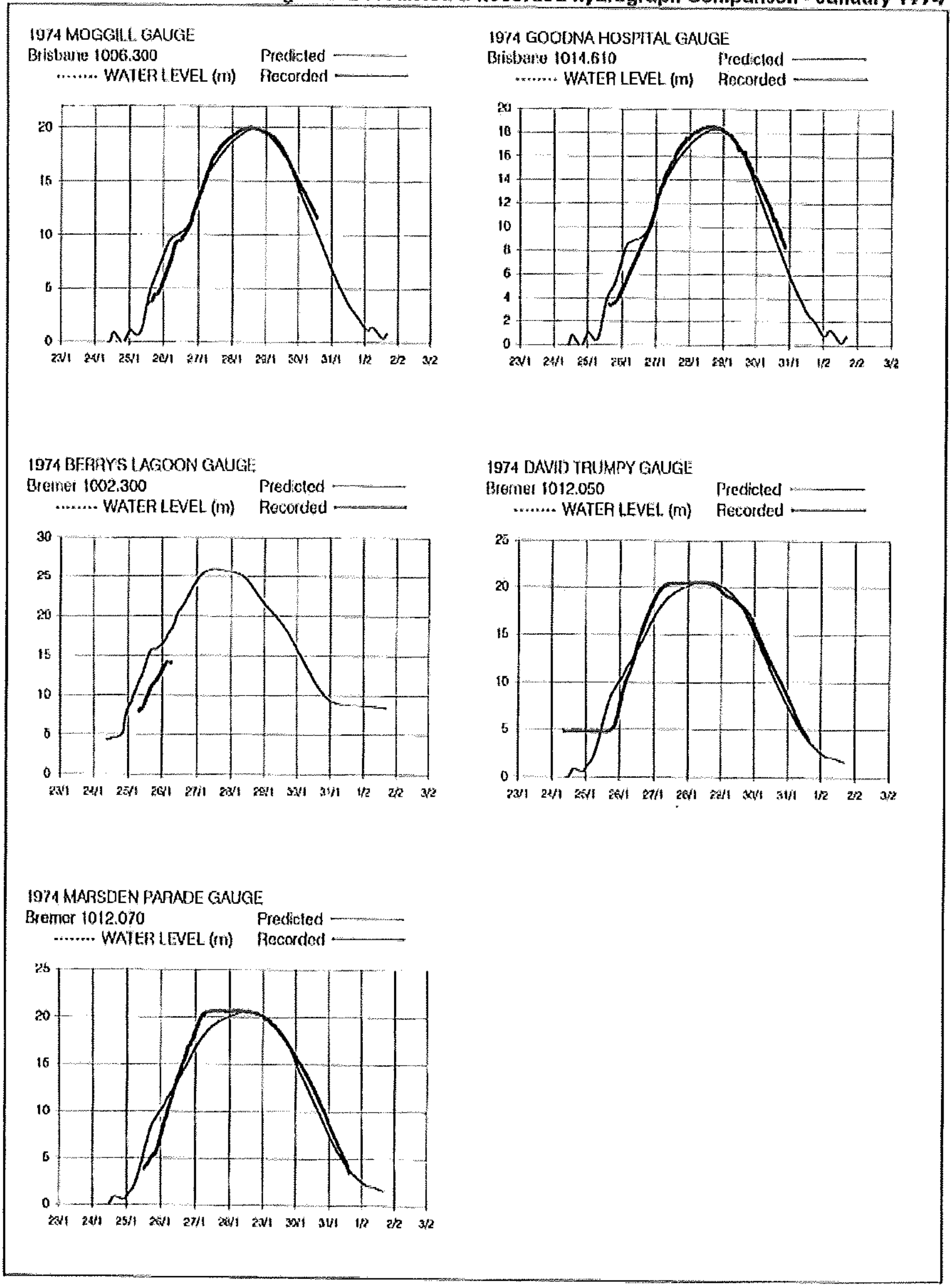


Figure D-3a Predicted & Recorded Hydrograph Comparison - May 1996

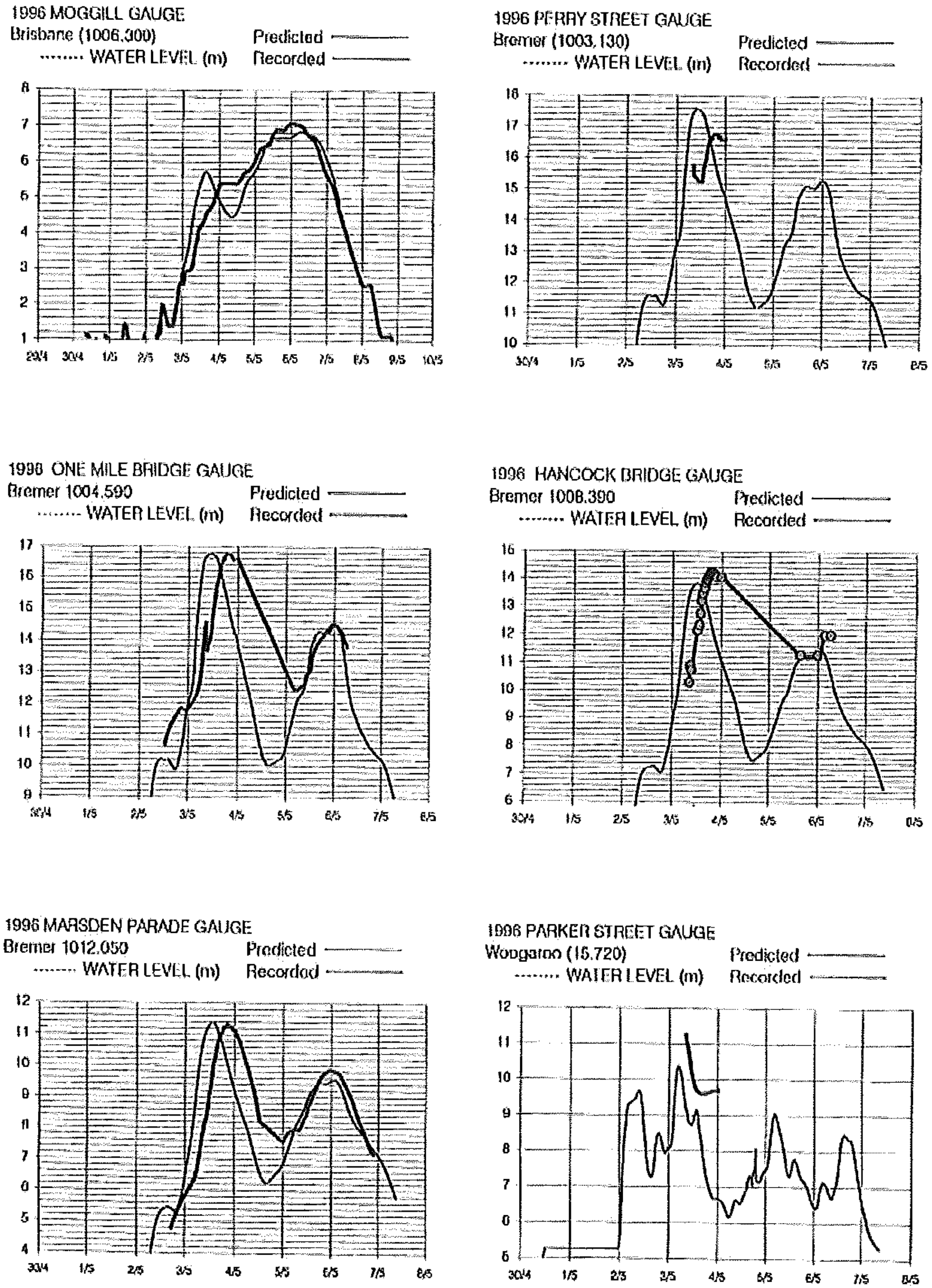


Figure D-3b Predicted & Recorded Hydrograph Comparison - May 1996

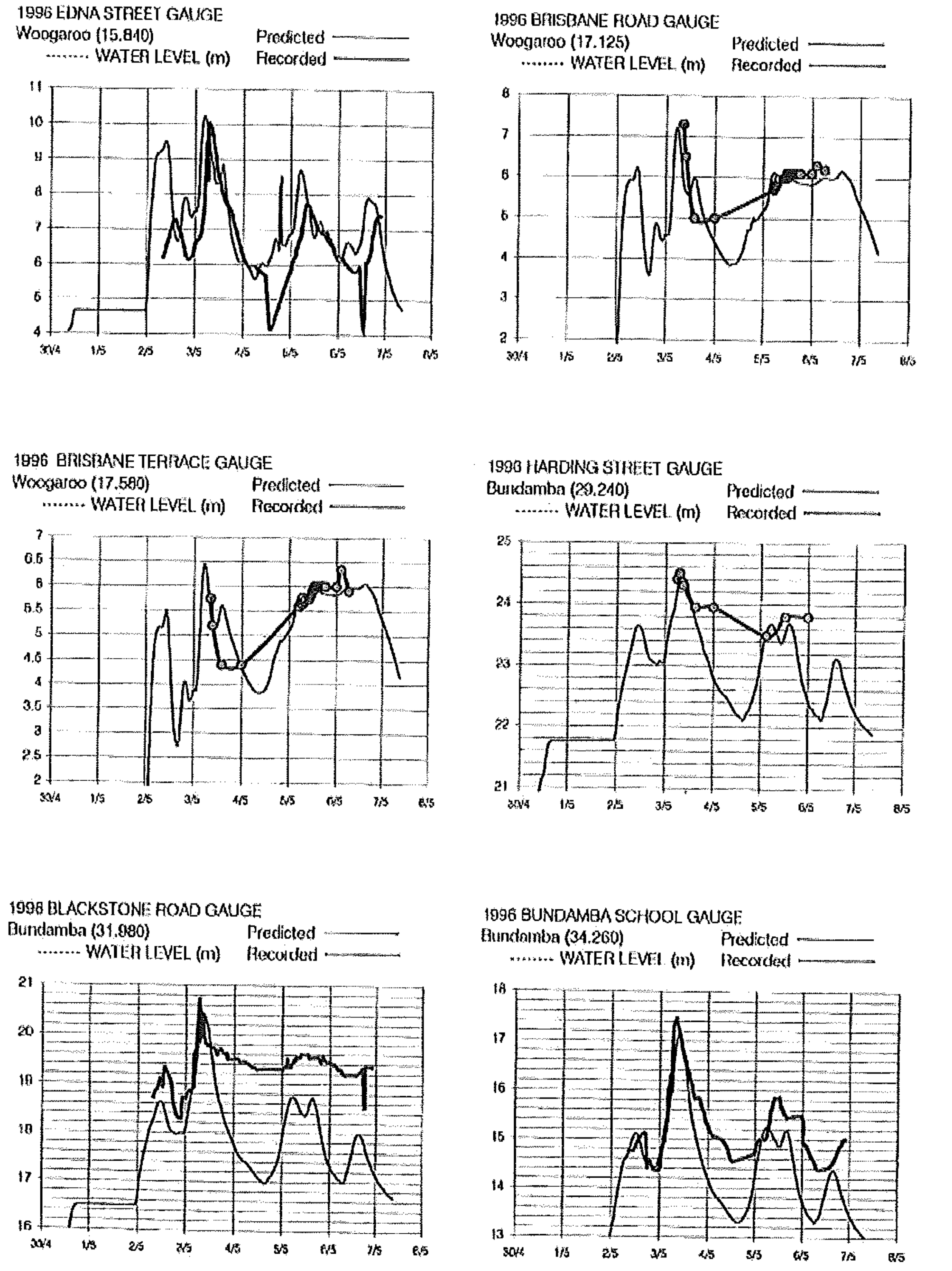


Figure D-4a Predicted & Recorded Hydrograph Comparison - April 1989

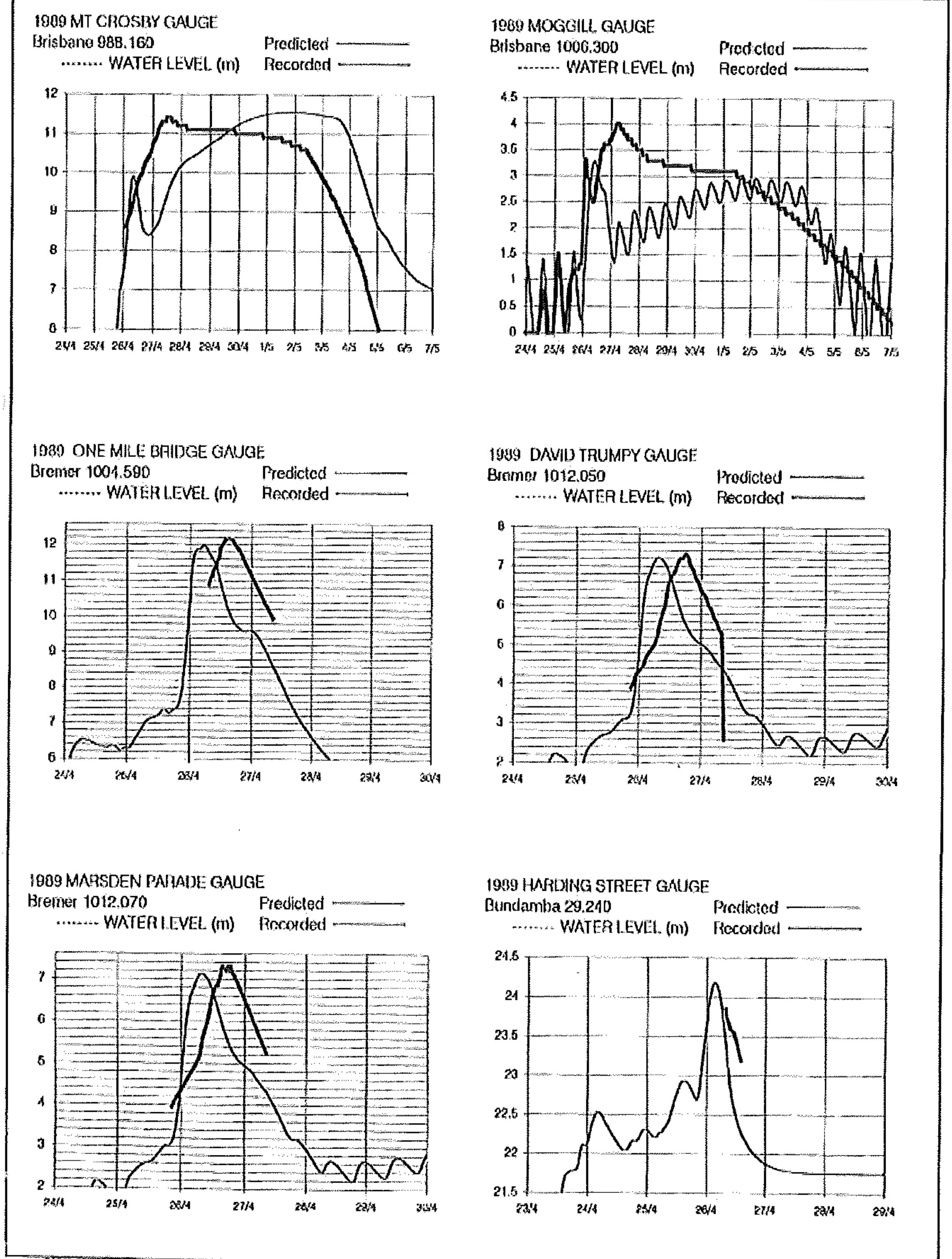
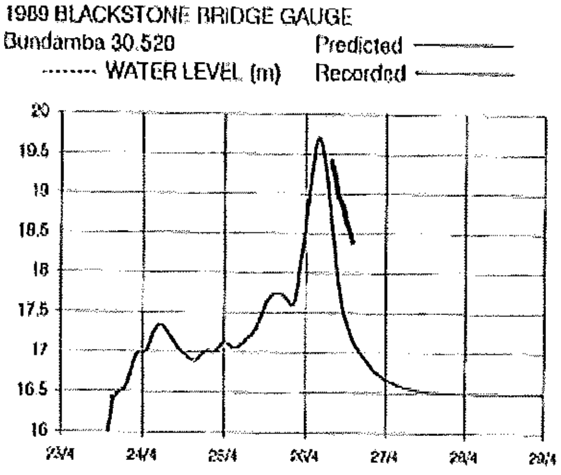


Figure D-4b Predicted & Recorded Hydrograph Comparison - April 1989



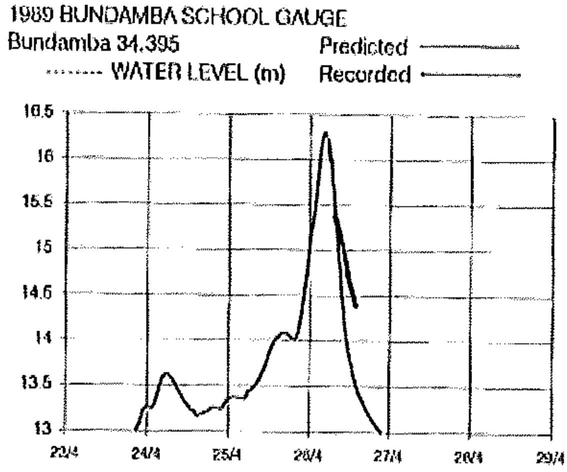


Figure D-5a Predicted & Recorded Hydrograph Comparison - June 1983

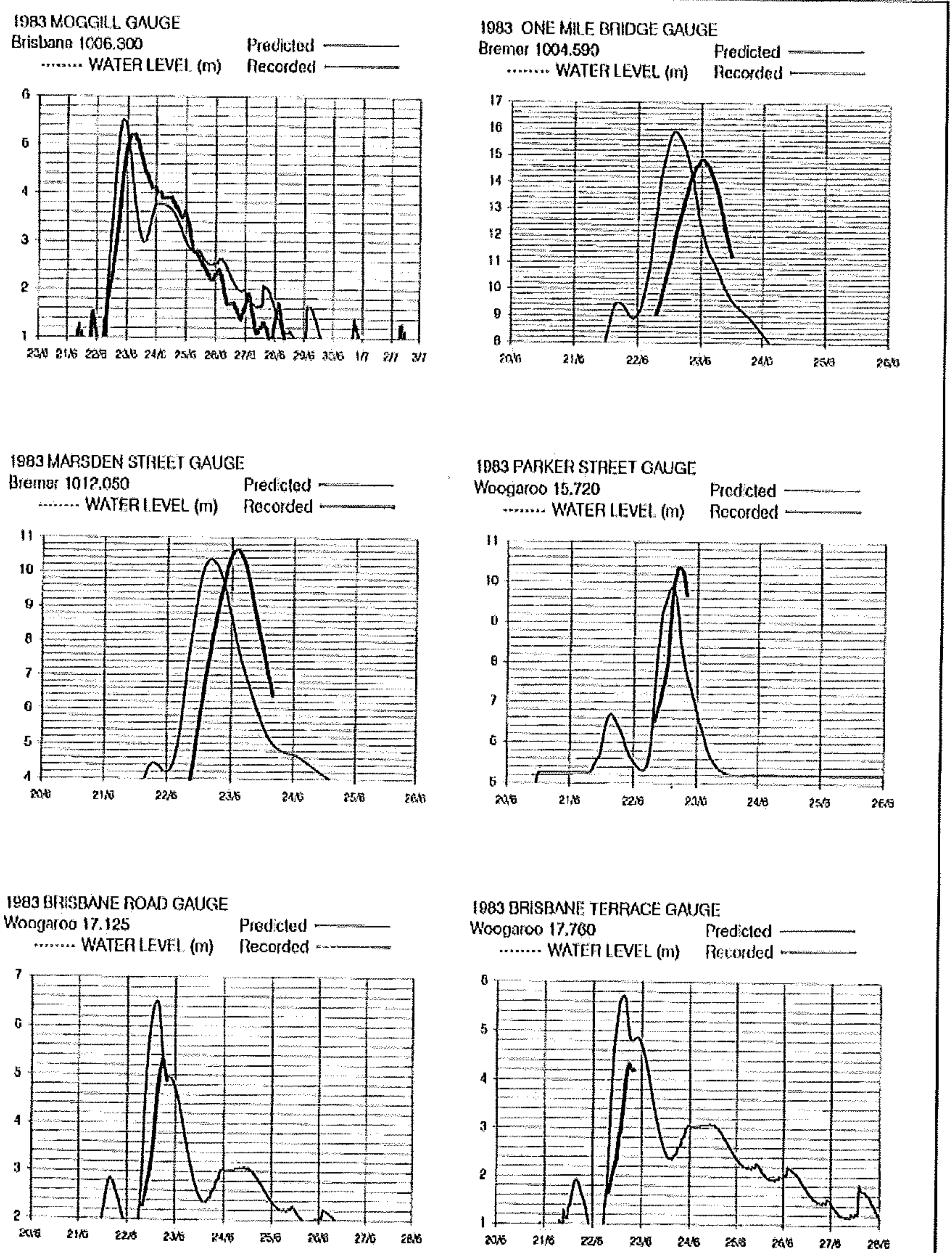
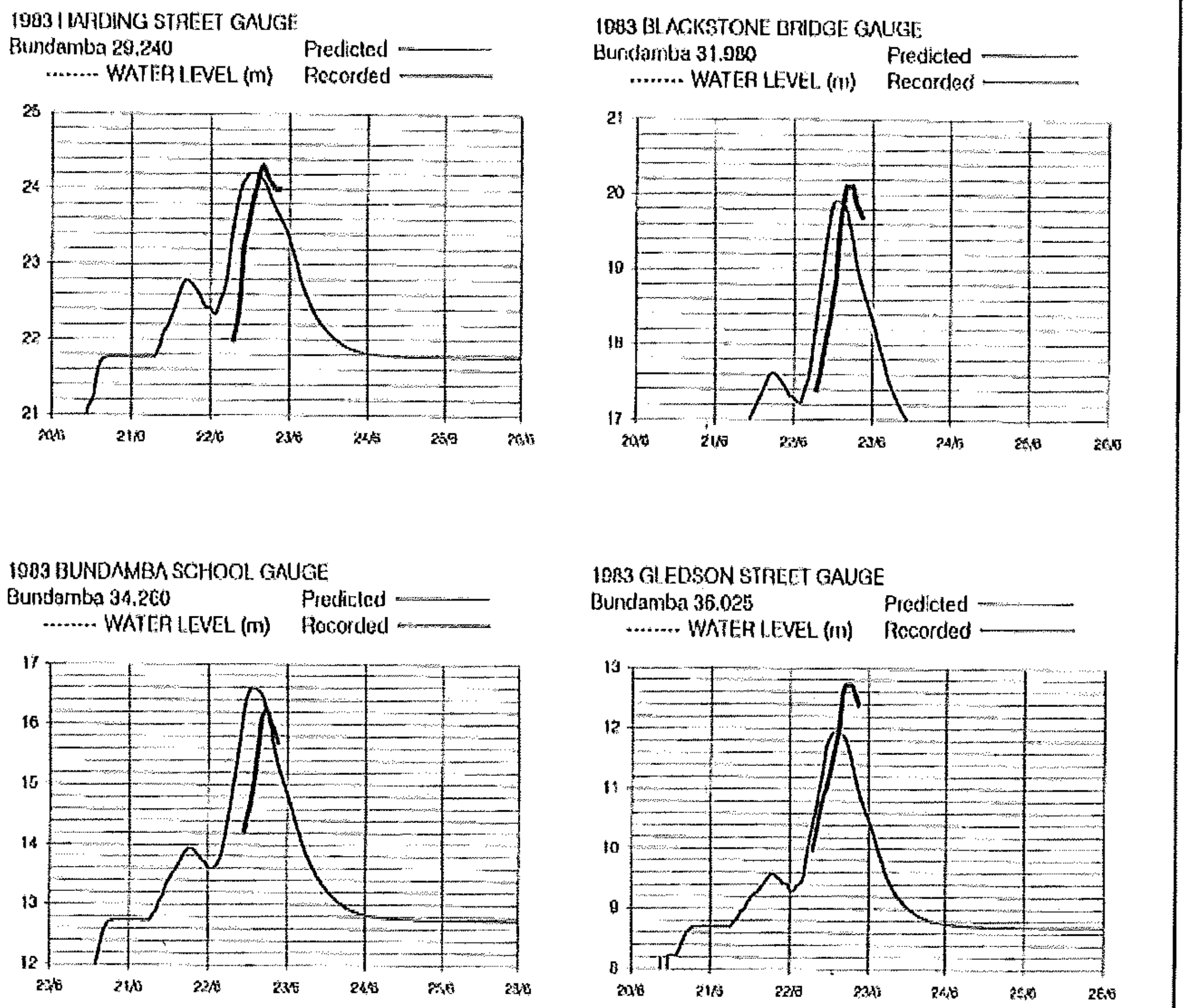
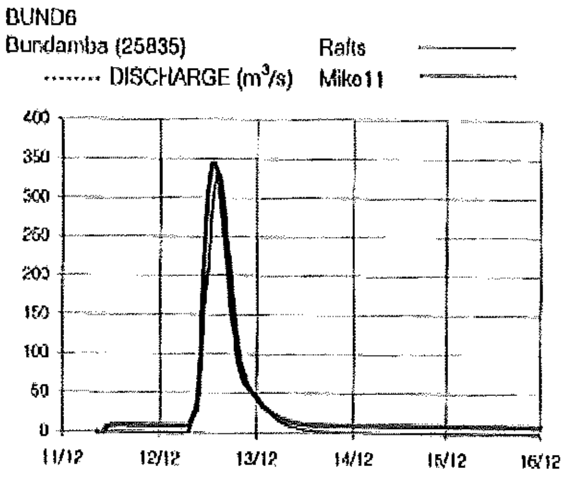


Figure D-5b Predicted & Recorded Hydrograph Comparison - June 1983



Appendix E - Consistency between MIKE11 and RAFTS

Figure E-1 1991 Hydrologic and Hydraulic Model Calibration



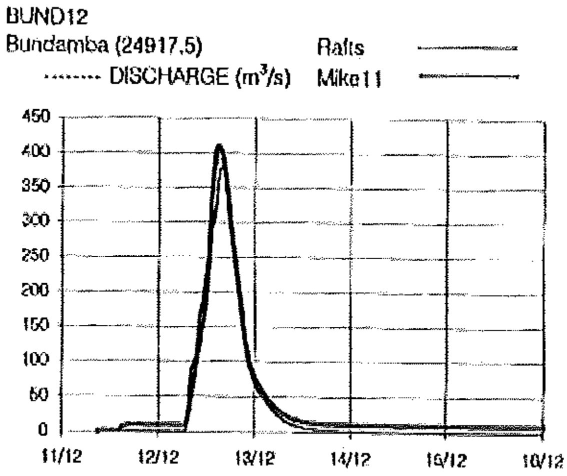
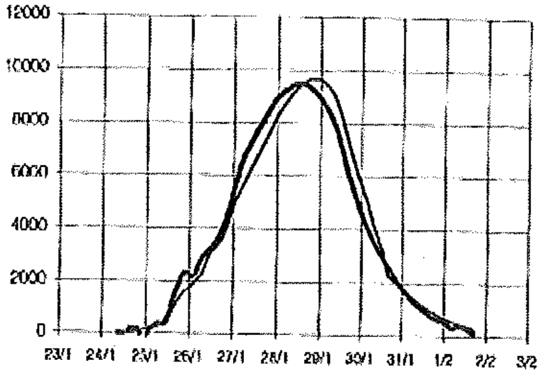
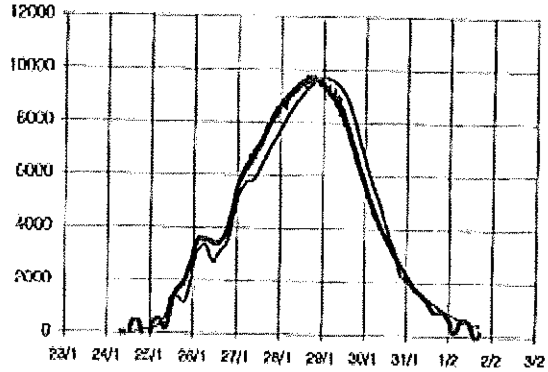


Figure E-2a - 1974 Hydrologic and Hydraulic Model Consistency

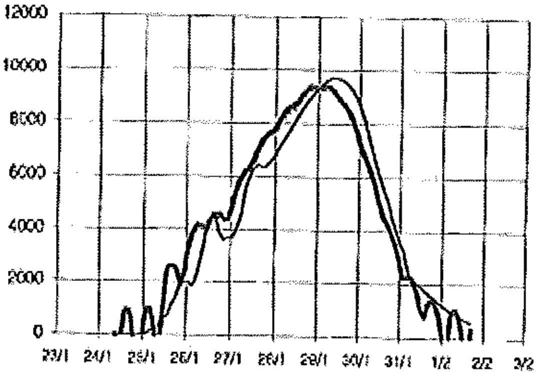
JIN### Moggill
Brisbane R (1006250)
······· DISCHARGE (m³/S)
Difference= 2.0%
Rafts
Mike11



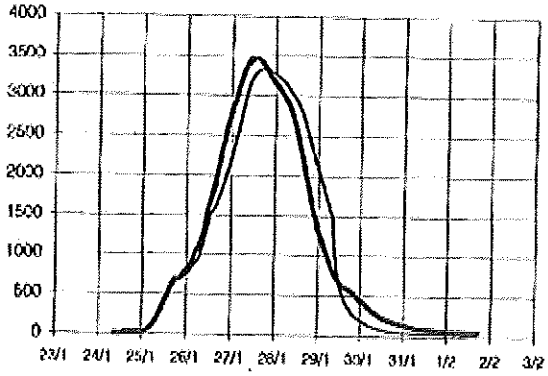
JIN-OUT Jindalee
Brisbane R (1028430)
······· DISCHARGE (m³/S)
Difference= 0.5%
Rafts
Mike11



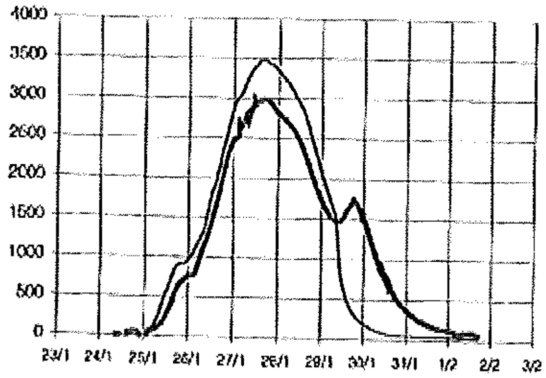
POG-OUT Port Office
Brisbane R (1055350)
······· DISCHARGE (m³/S)
Difference= 3.3%
Rafts
Mike11



2C# David Trumpy
Bremer R (1012060)
······· DISCHARGE (m³/S)
Difference= 4.0%
Rafts
Mike11



1A
Bremer R (1023500)
······· DISCHARGE (m³/S)
Difference= 14.3%
Rafts
Mike11



JINAN Ipswich Road
Six Mile Ck (19850)
······· DISCHARGE (m³/S)
Difference= 0.9%
Rafts
Mike11

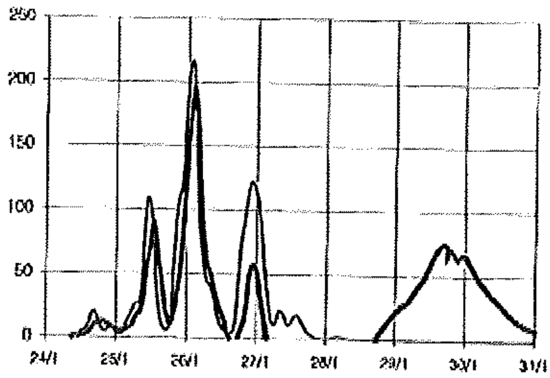


Figure E-2b - 1974 Hydrologic and Hydraulic Model Consistency

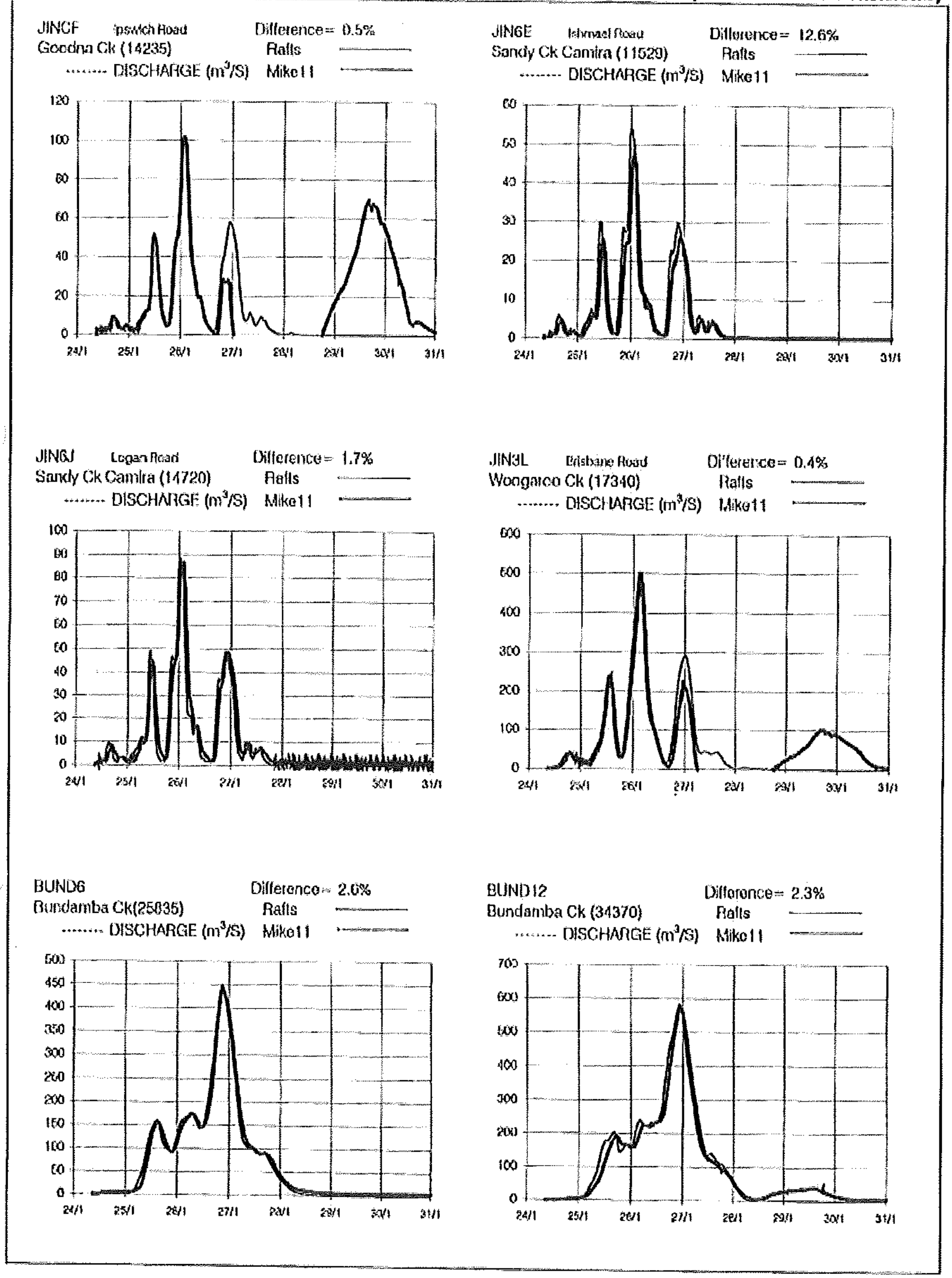


Figure E-2c - 1974 Hydrologic and Hydraulic Model Consistency

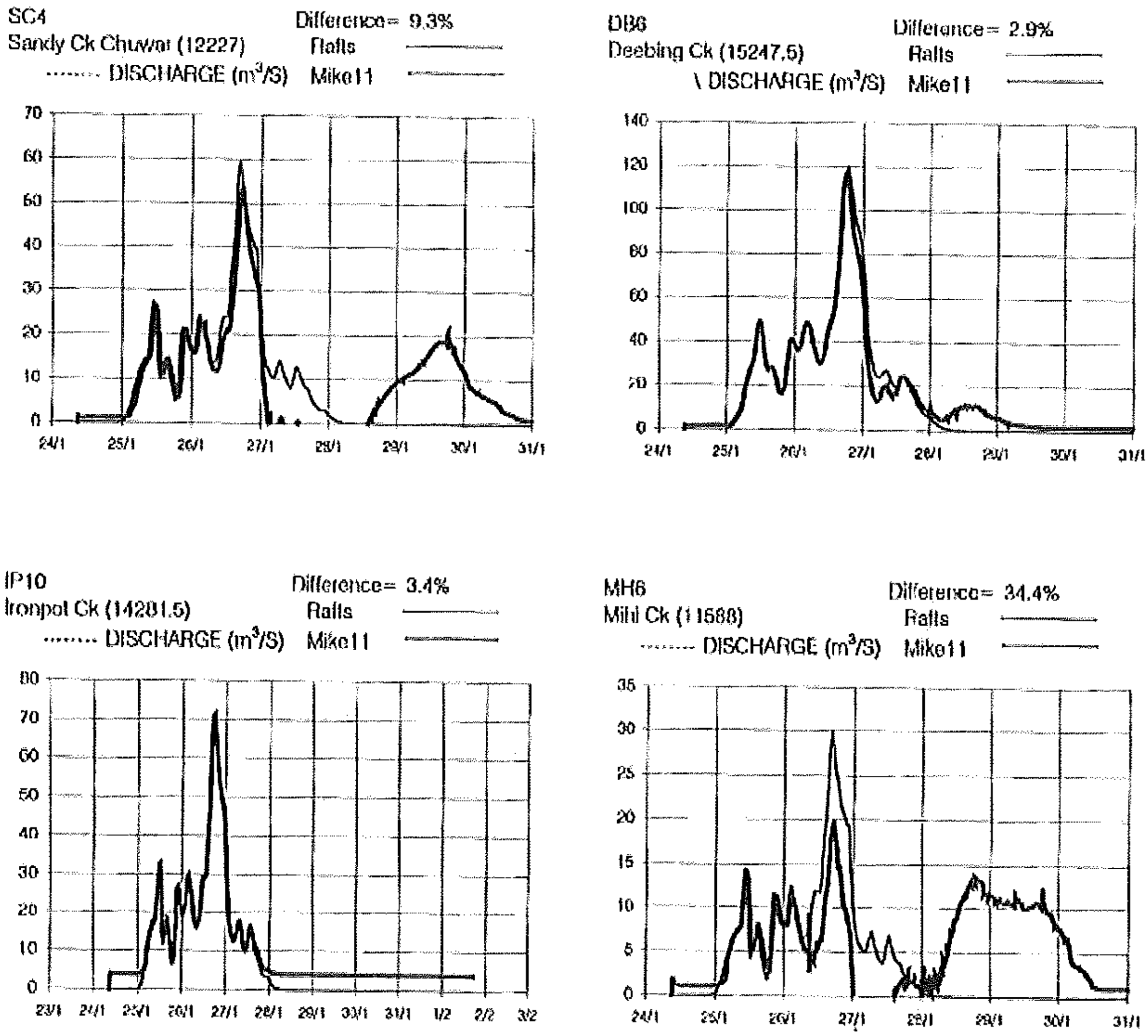


Figure E-3a 1996 Hydrologic and Hydraulic Model Calibration

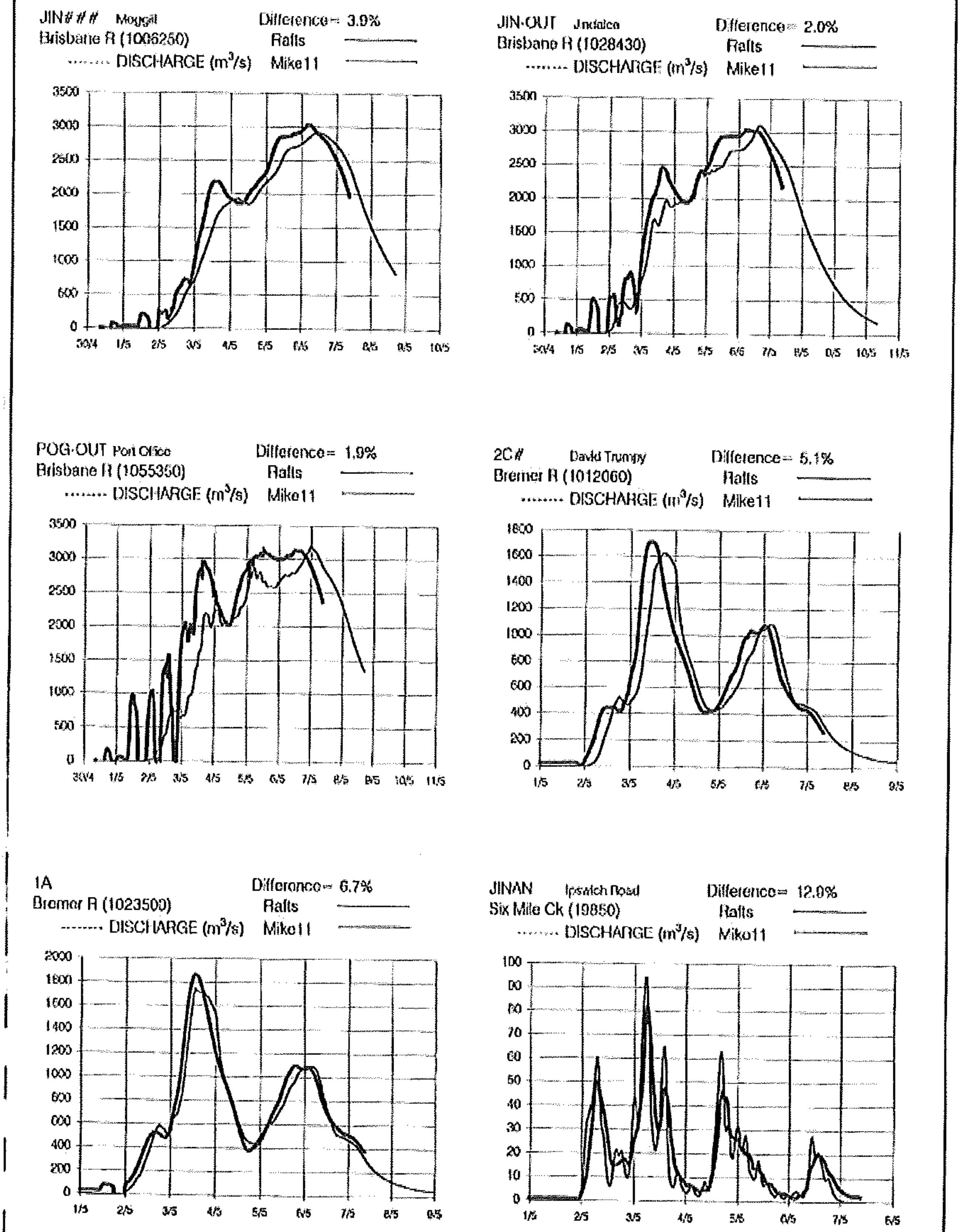


Figure E-3b 1996 Hydrologic and Hydraulic Model Calibration

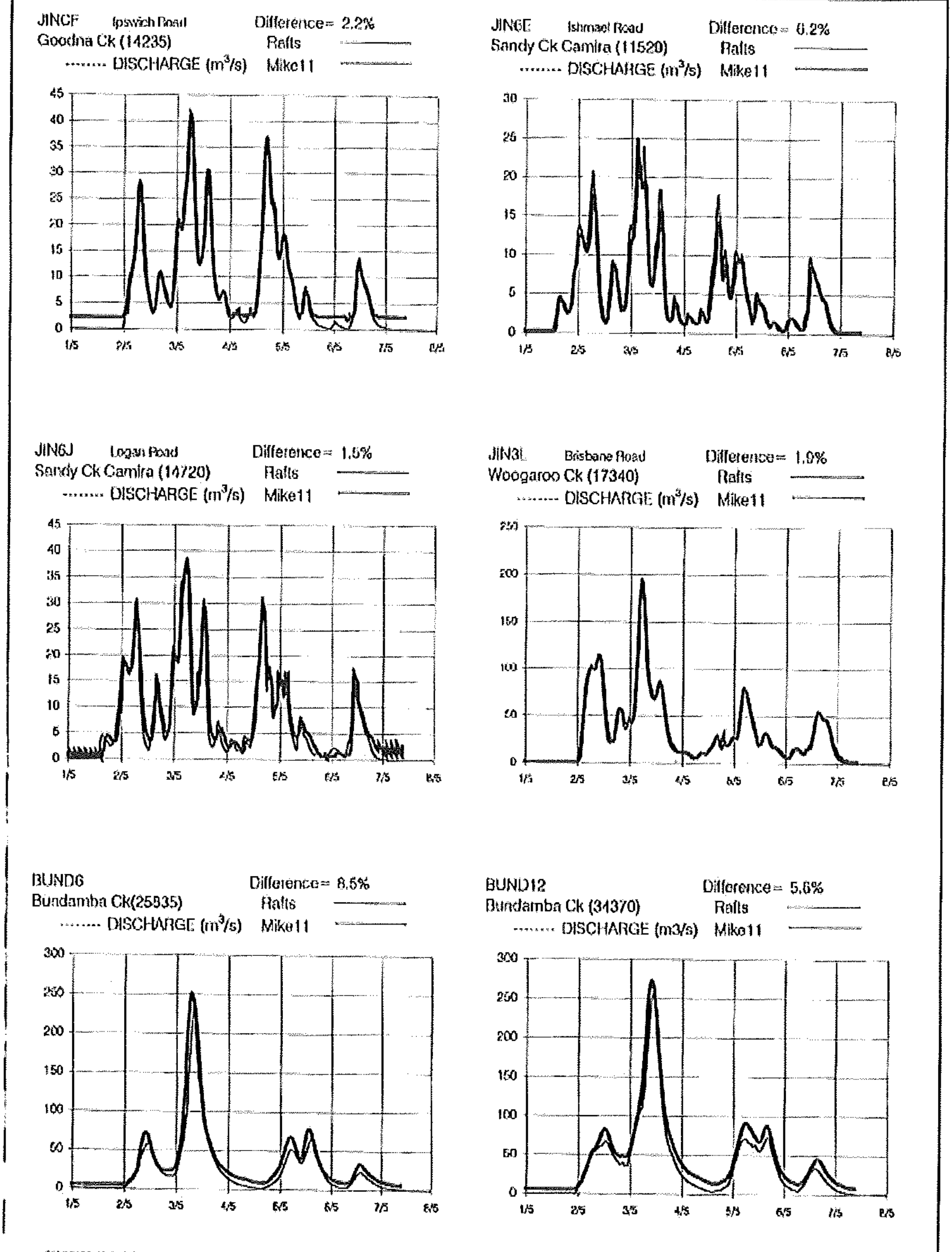


Figure E-3c 1996 Hydrologic and Hydraulic Model Calibration

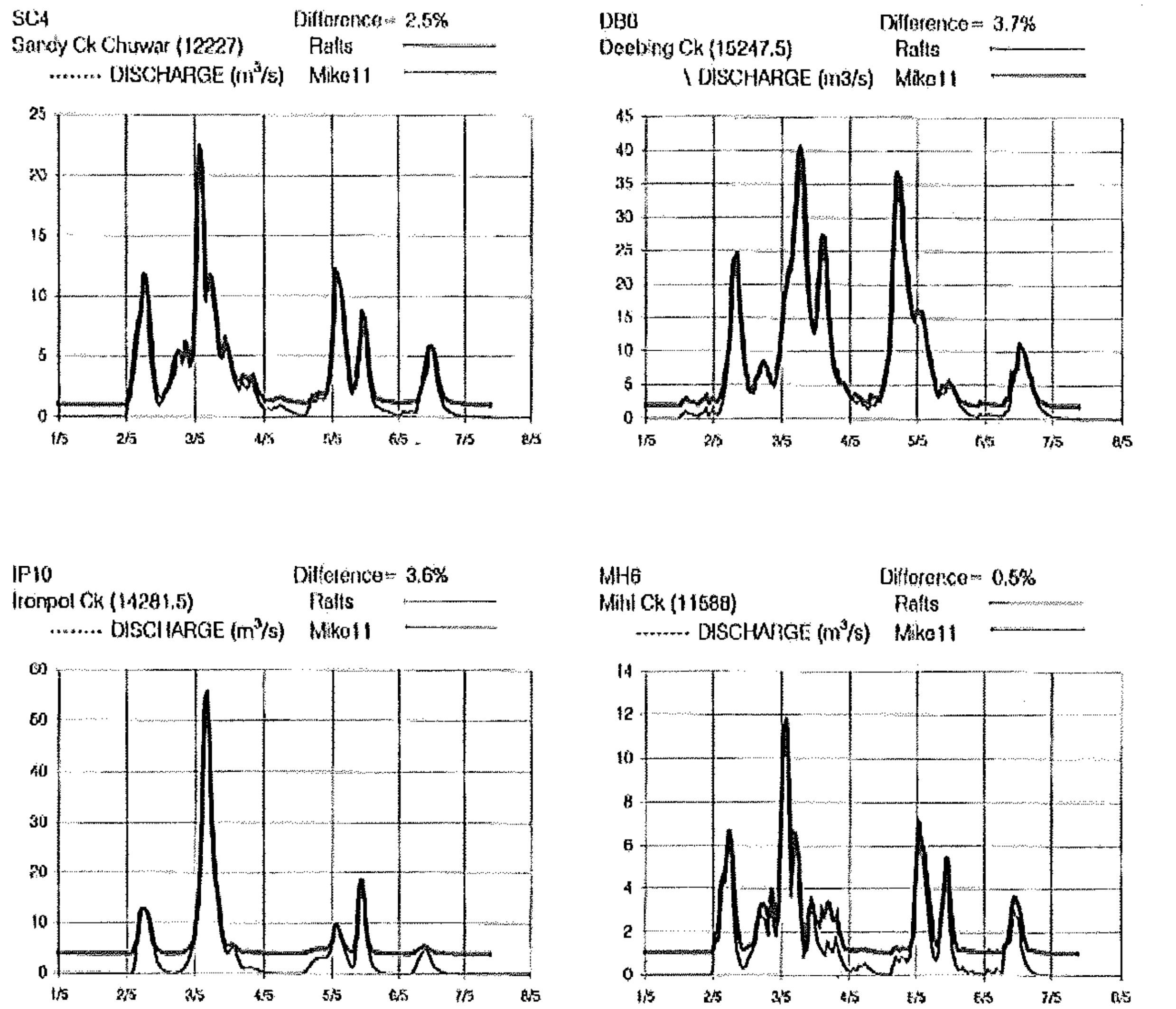


Figure E-4a - 1989 Hydrologic and Hydraulic Model Consistency

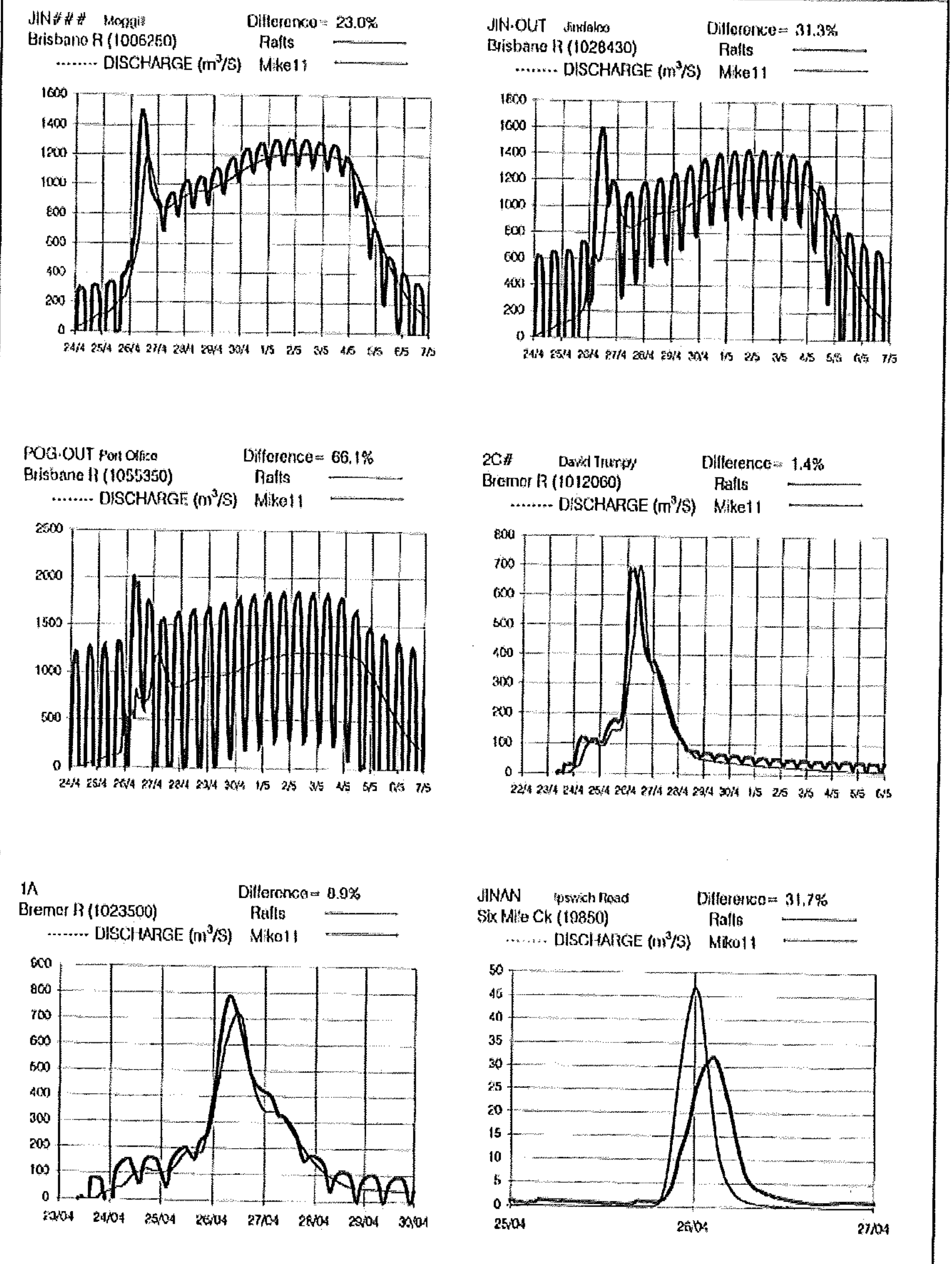


Figure E-4b - 1989 Hydrologic and Hydraulic Model Consistency

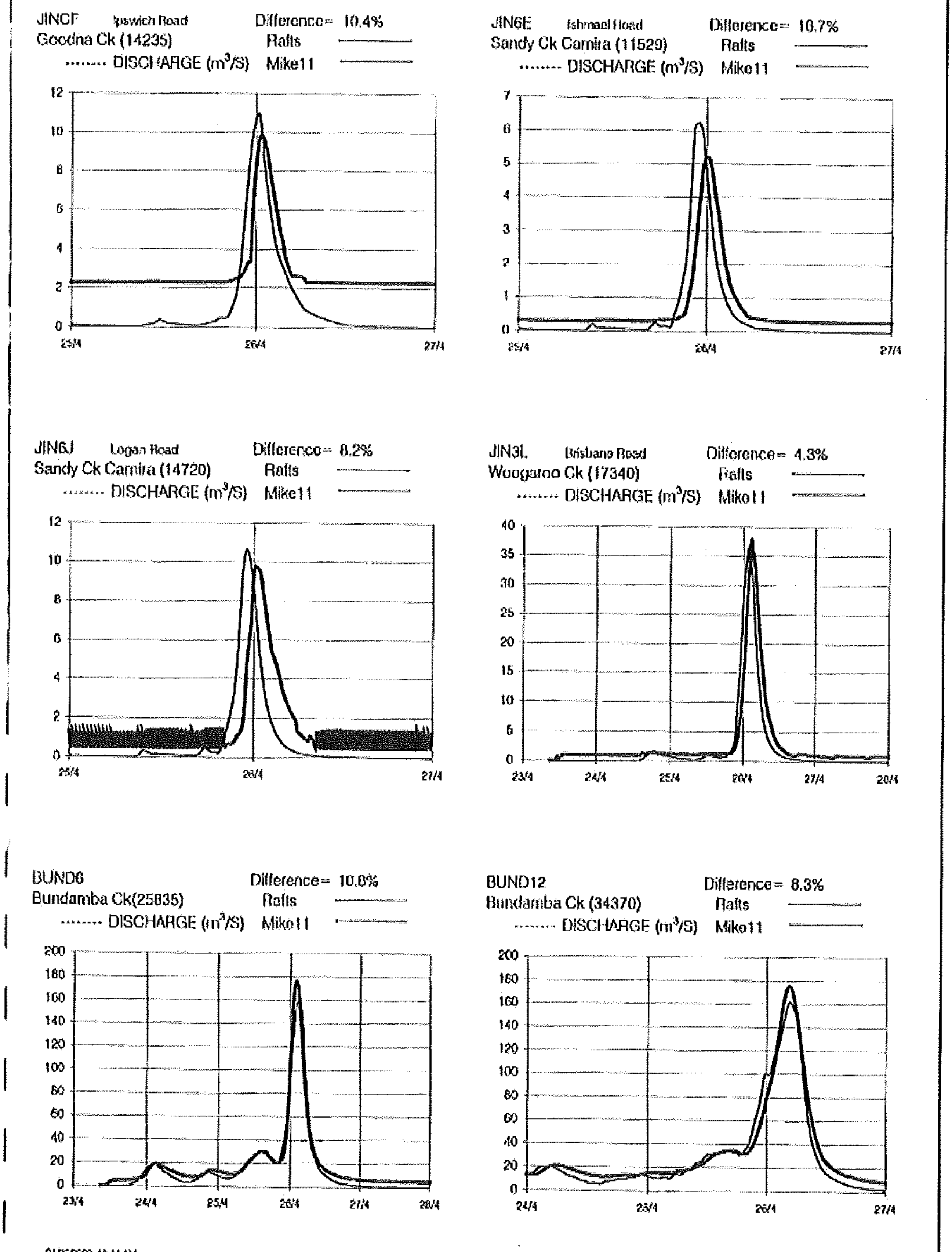
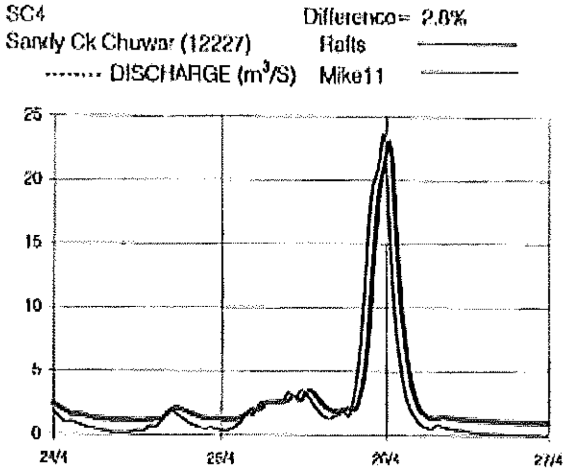
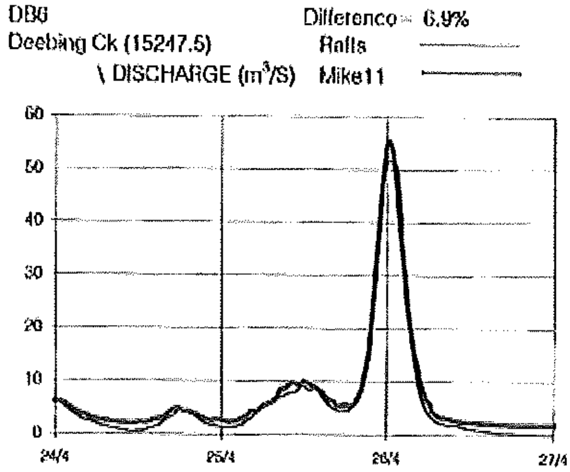
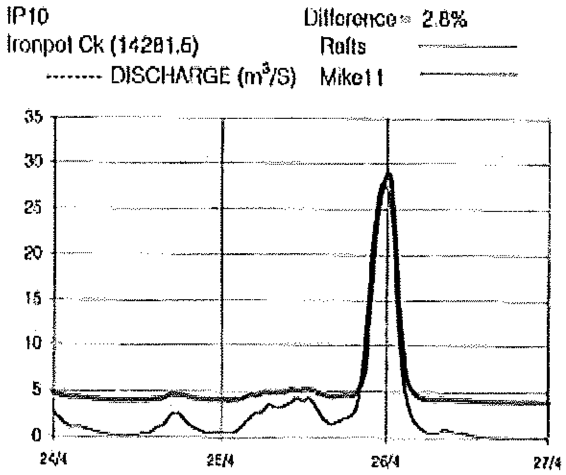


Figure E-4c - 1989 Hydrologic and Hydraulic Model Consistency







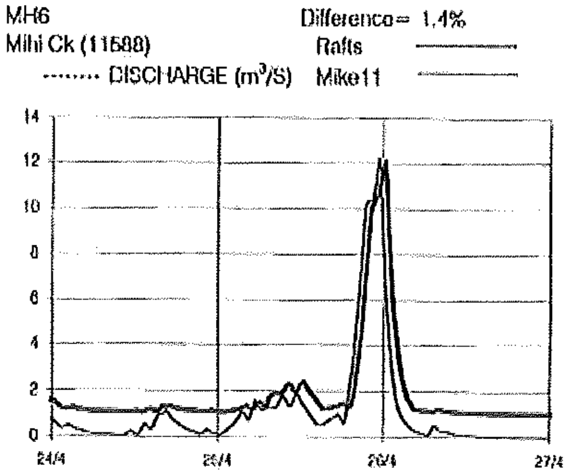


Figure E-5a - 1983 Hydrologic and Hydraulic Model Consistency

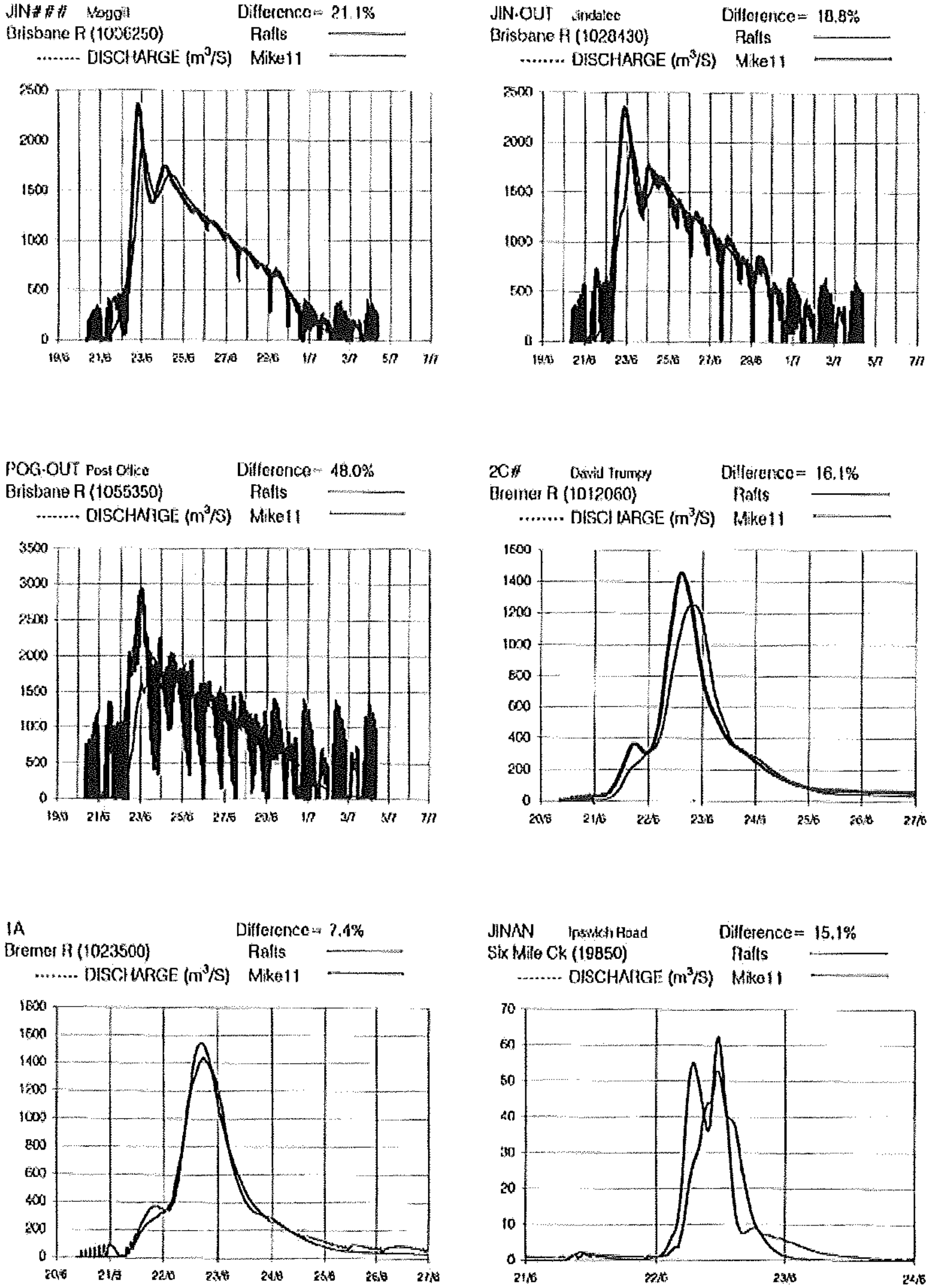


Figure E-5b - 1983 Hydrologic and Hydraulic Model Consistency

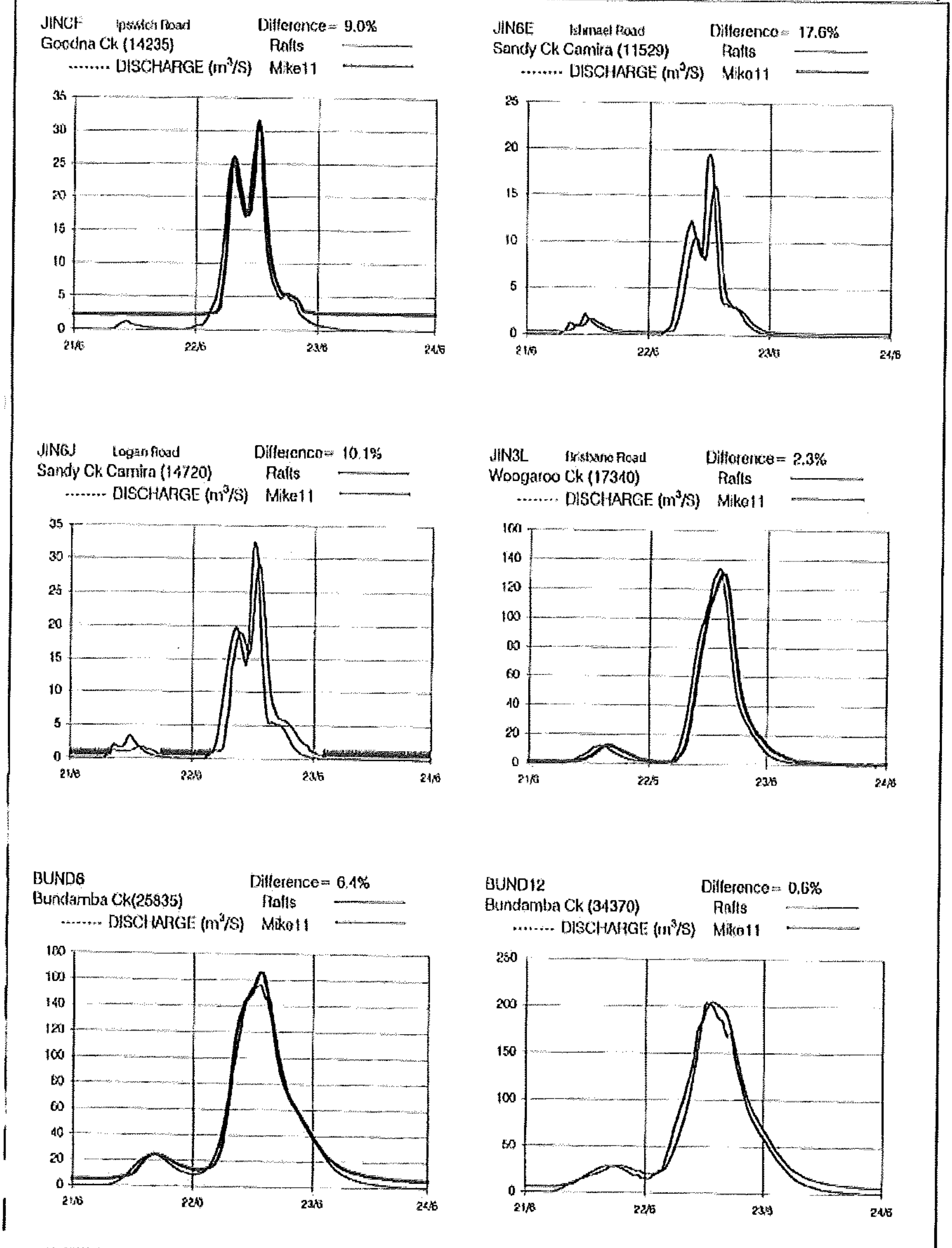
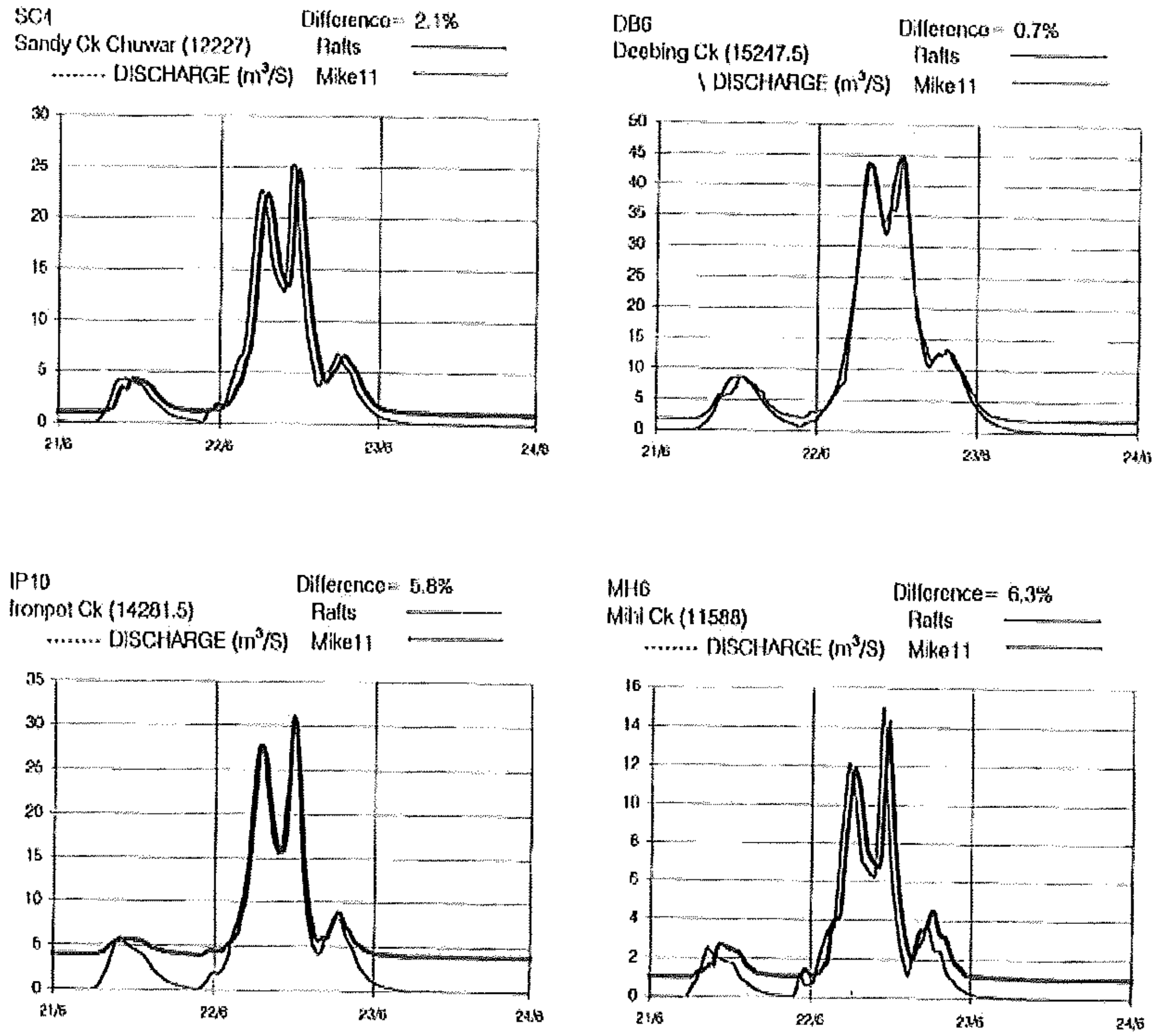


Figure E-5c - 1983 Hydrologic and Hydraulic Model Consistency



Appendix F - Probable Maximum Precipitation Methods

- Generalised Short Duration Method (GSDM)
- Generalised Tropical Storm Method (GTSM)

INSTRUCTIONS FOR THE USE OF THE GTSM PMP SPATIAL DISTRIBUTION DIAGRAMS

1. Select the appropriate distribution diagram according to whether the area of the catchment is above or below 2000 km^2.

2. Expand or contract the scale of the isohyetal pattern until the outermost isohyet just touches the catchment. Adjust the positioning of the pattern to get an (estimated) highest PMP depth over the catchment. This depends on the shape of the catchment as well as the position of the pattern.

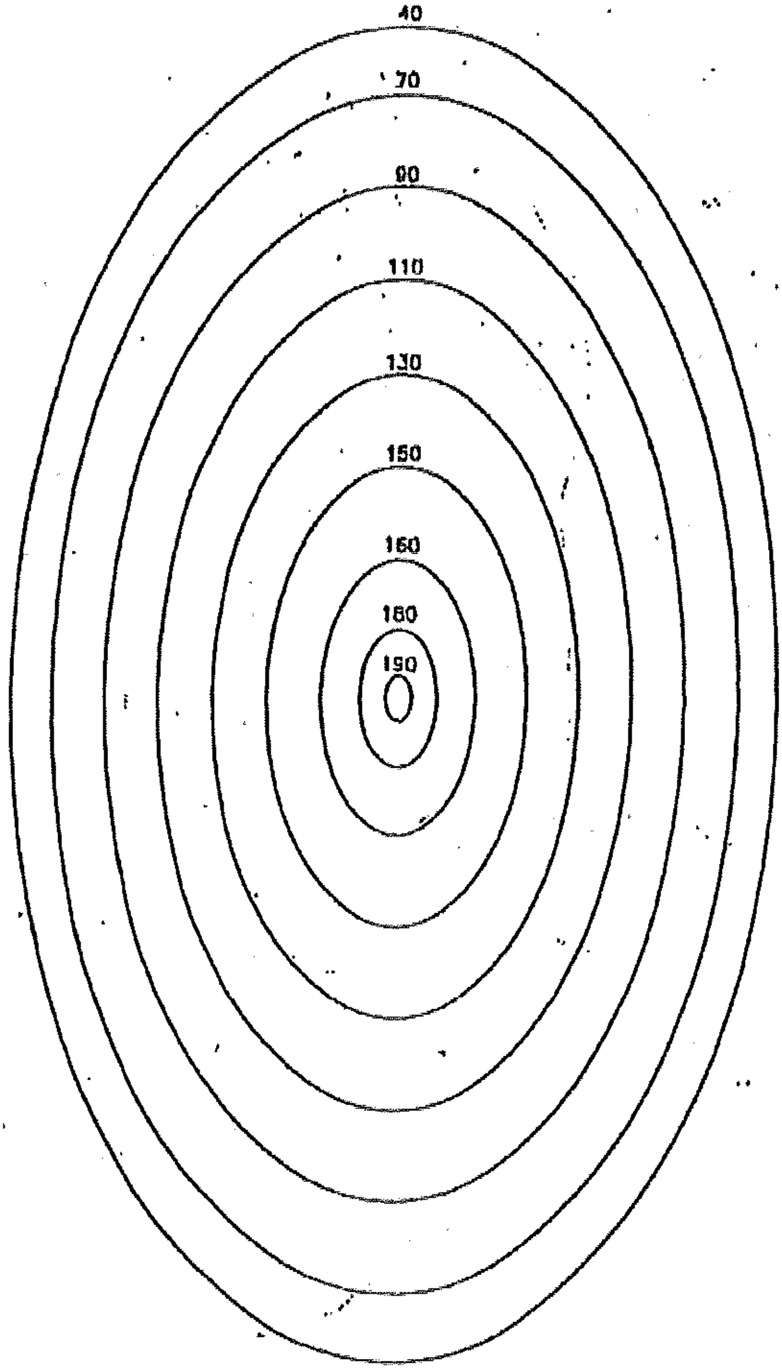
3. Calculate the area of the catchment within the central isohyet, and then between each adjacent pair of isohyets until all these areas have been calculated. A planimeter or other means are suitable methods of doing this.

4. Multiply the percentage assigned to the label on each isohyet by the mean PMP depth for that duration. This gives isohyet labels in millimeters.

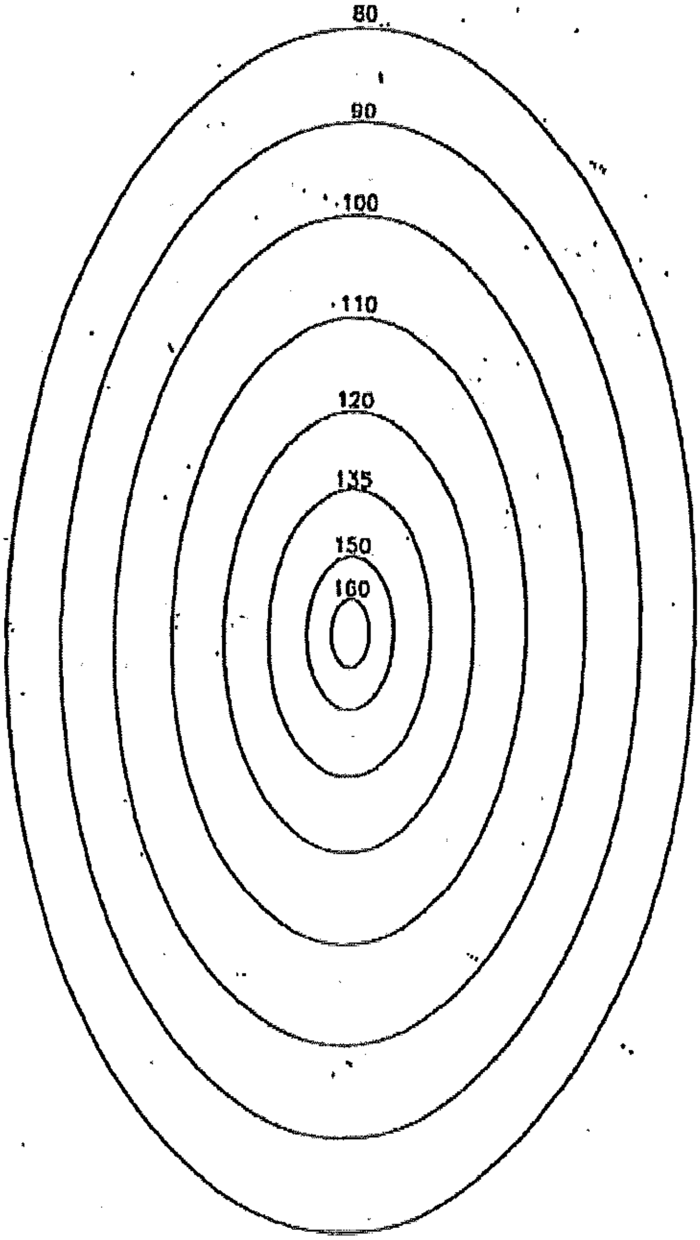
5. Multiply these areas by an estimate of the mean rainfall value over that part of the catchment contained in the annulus between each successive pair of isohyets. This will generally not be the arithmetic mean because of the usually irregular shape of the catchment boundary. For the central isohyet a mean value has to be estimated. This will not be critical.

6. The sum of all the above products is divided by the total catchment area to obtain the calculated mean catchment PMP depth. This will usually not be equal to the true PMP depth. The ratio of the actual PMP to the calculated PMP values is then calculated.

7. The values of the isohyetal labels are all multiplied by this ratio (ie a constant scaling factor) to ensure that the isohyetal pattern gives the correct mean PMP depth.



Generalised Tropical Storm Method Design Isohyetal Pattern for distribution of PMP for Areas >2000 sq km.
(% of mean catchment value)



Generalised Tropical Storm Method Design Isohyetal Pattern for the Distribution of PMP over Areas <= 2000 sq km (% of mean catchment value)

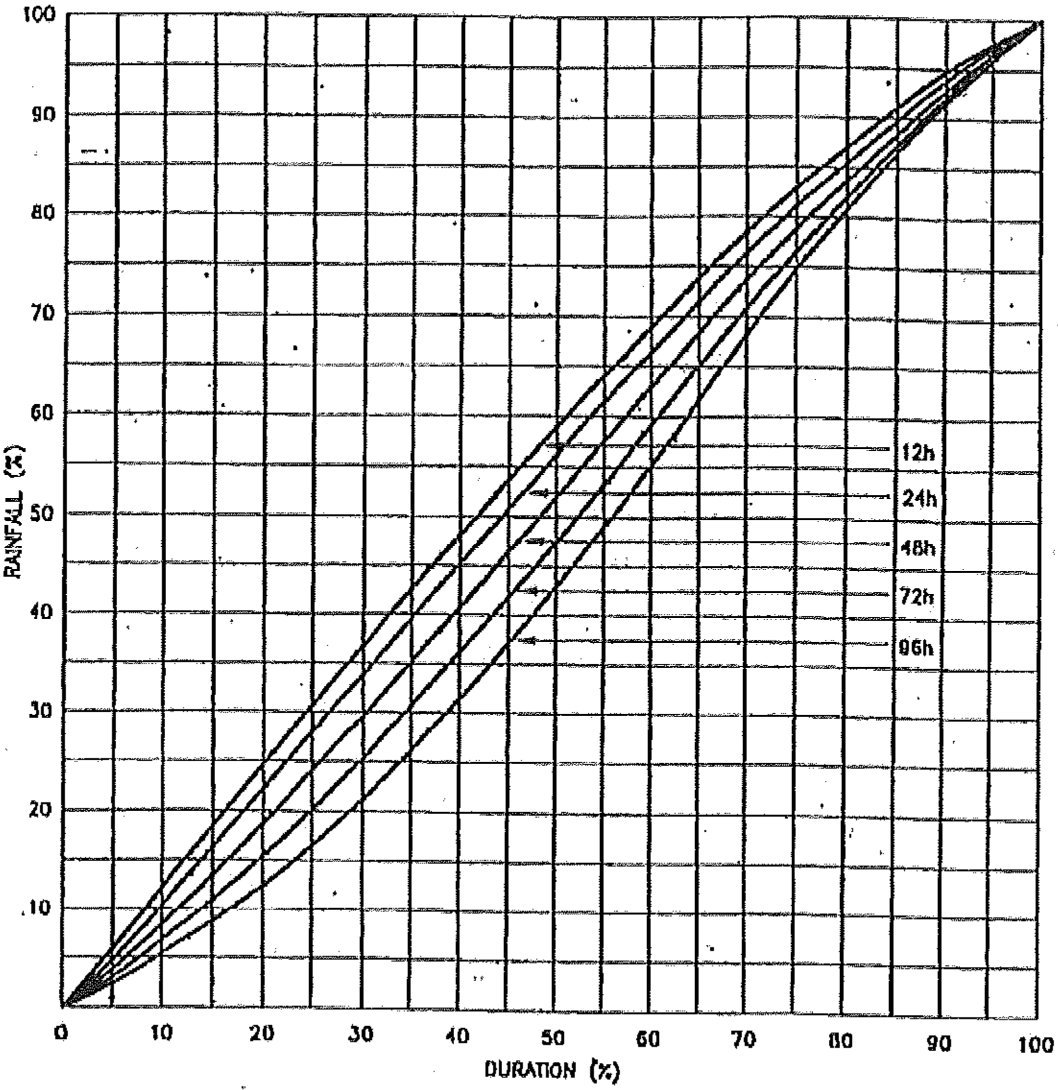


Figure 3 : Design Temporal Patterns of GTSM PMP for the "East Coast Tropical Zone" for durations of 12, 24, 48, 72 and 96 hours

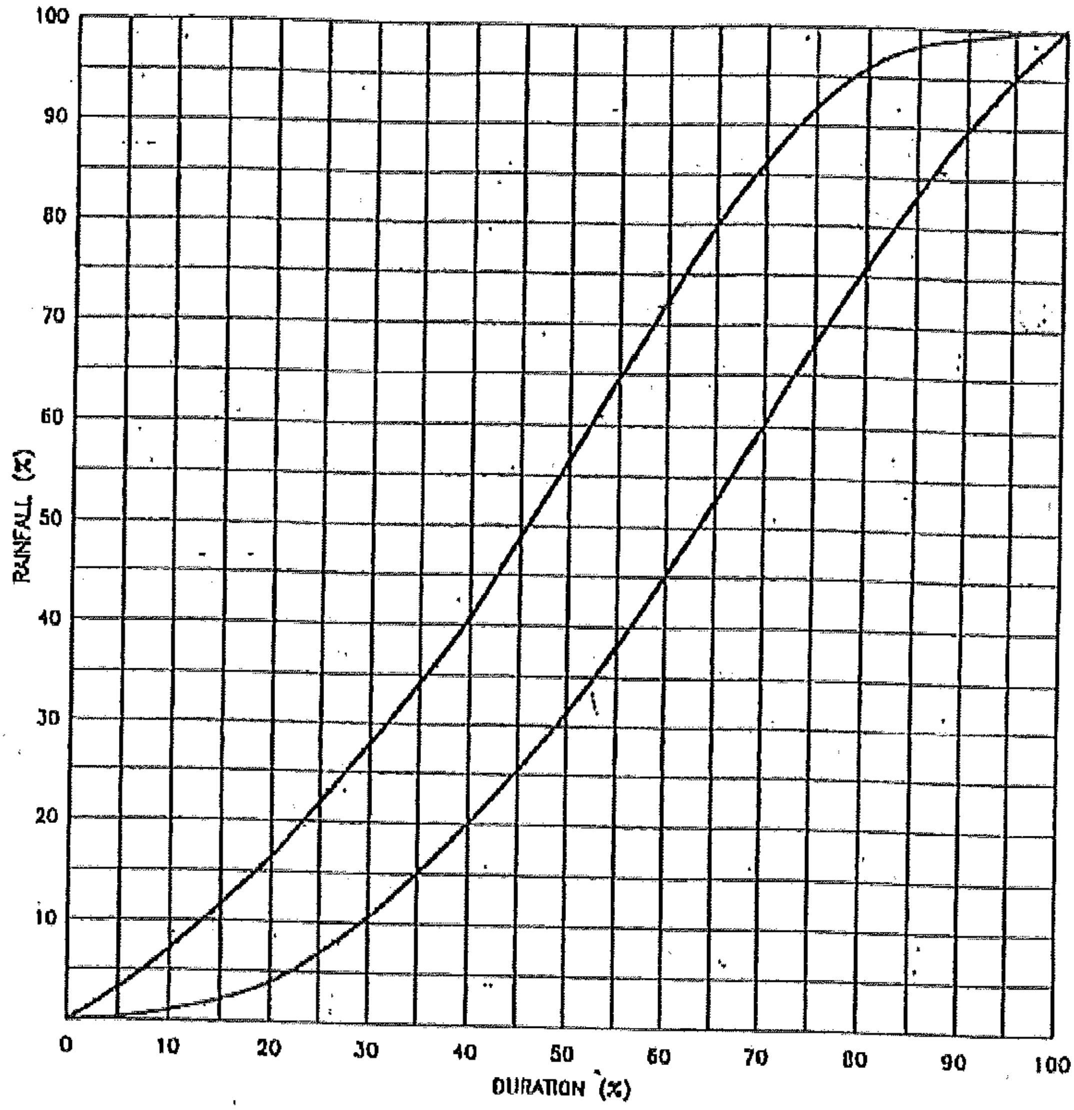


Figure 4 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 120 hours

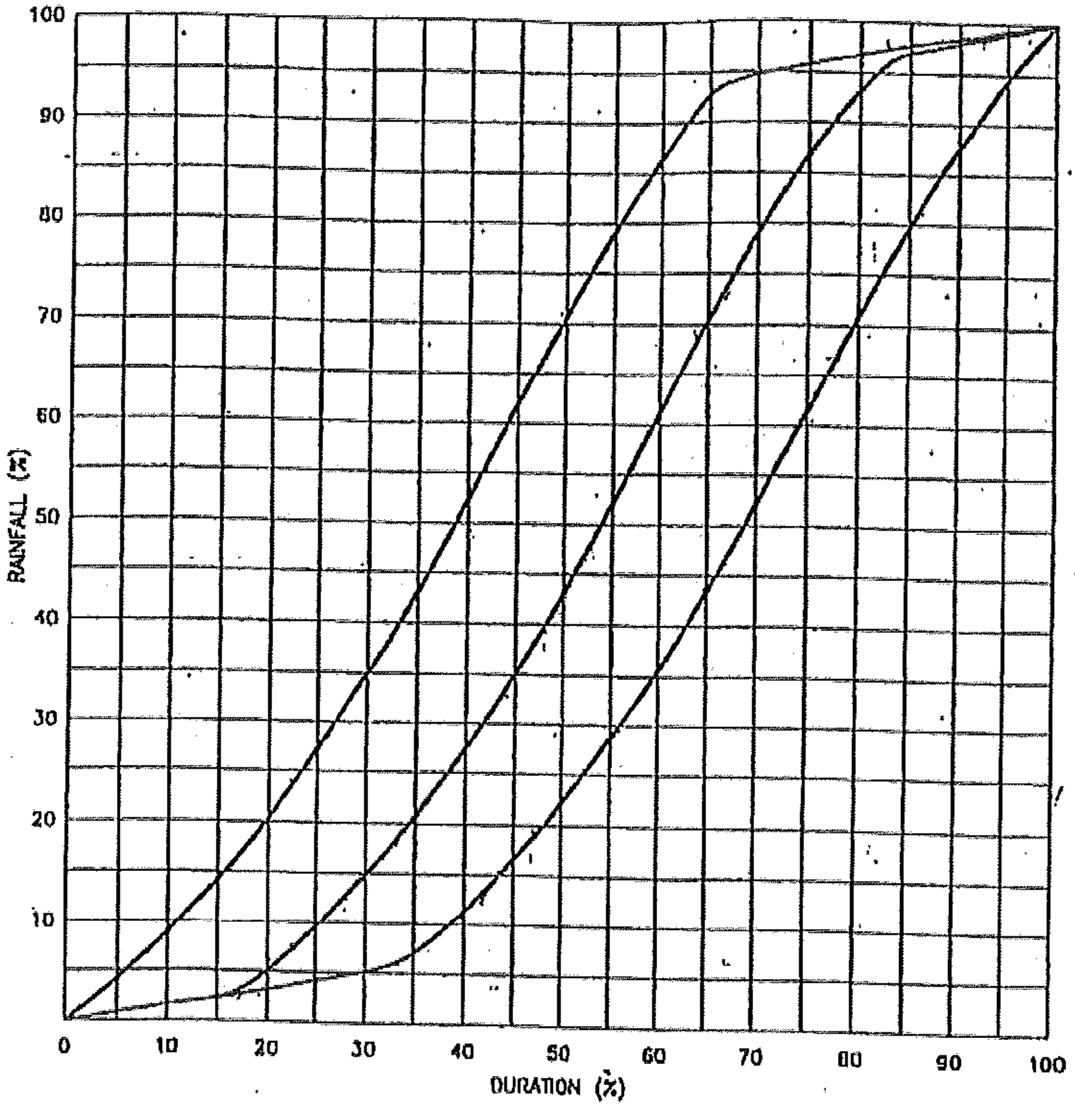


Figure 5 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 144 hours

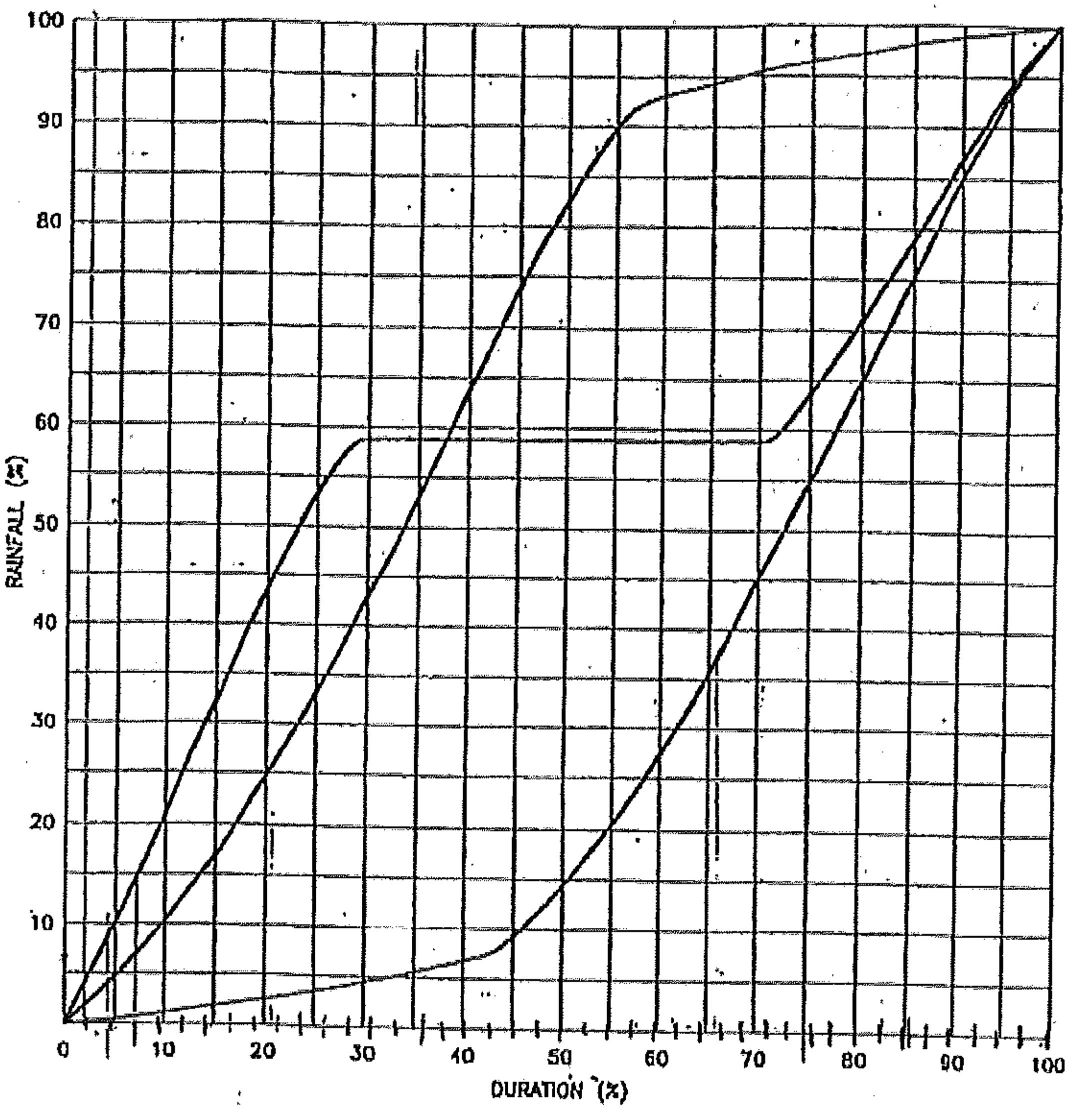


Figure 6 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 168 hours

6. Design spatial distribution of PMP

The design spatial distribution for convective storm PMP is given in Figure 10. It is based on that given by the United States Weather Bureau (1966) and the World Meteorological Organization (1986) but has been modified in the light of Australian experience. It assumes a virtually stationary storm and can be oriented in any direction with respect to the catchment. Instructions for the application of the spatial distribution are given below and an example is given in Appendix 2.2.

For simplicity and consistency of application, it is recommended that PMP depth be distributed using a step-function approach. This means having a constant value at all points in the interval between consecutive ellipses (or within the central ellipse), and stepping to a new constant value at each new ellipse. This constant value between ellipses is the mean rainfall depth for that interval and is derived by the procedure described below.

Instructions for the use of the spatial distribution diagram

Step 1 Positioning the spatial distribution diagram

Enlarge or reduce the size of the spatial distribution diagram (Figure 10) to match the scale of the catchment outline map. Overlay the spatial distribution diagram on the catchment outline and move it to obtain the best fit by the smallest possible ellipse. This ellipse is now the outermost ellipse of the distribution.

Step 2 Areas of catchment between successive ellipses

Determine the area of the catchment lying *between* successive ellipses ($CBtn_i$, where the ith ellipse is one of the ellipses A to J).
Where the catchment completely fills both ellipses, this is just the difference between the areas enclosed by each ellipse as given in Table 2:

$$CBtn_i = Area_i - Area_{i-1}$$

Where the catchment only partially fills the interval between ellipses, use planimetering or a similar method to determine this area.

Step 3 Area of catchment enclosed by each ellipse

Determine the area of the catchment *enclosed by* each ellipse ($CEnc_i$):

$$CEnc_i = \sum_{k=A}^{i} CBtn_k$$

The area of the catchment enclosed by the outermost ellipse will be equal to the total area of the catchment.

Step 4 Initial mean rainfall depth enclosed by each ellipse

Obtain the x-hour initial mean rainfall depths ($IMRD_i$) for each of the areas enclosed by successive ellipses ($CEnc_i$) (Step 3).

Where the catchment completely fills an ellipse ($CEnc_i = Area_i$), determine the x-hour initial mean rainfall depth for this area from Table 2. Where the catchment only partially fills an ellipse ($CEnc_i < Area_i$), determine the x-hour initial mean rainfall depth for that area from the appropriate DDA curves (Figure 4).

Table 2 Initial mean rainfall depth enclosed by ellipses A-H in Figure 10.

Ellipse label	*Area enclosed (km^2)*	*Area between (km^2)*	*Initial mean rainfall depth (mm)* — *Duration (hours)* 0.25	0.5	0.75	1	1.5	2	2.5	3	4	5	6
SMOOTH													
A	2.6	2.6	232	336	425	493	563	628	669	705	771	832	879
B	16	13.4	204	301	383	449	513	575	612	642	711	765	811
C	65	49	177	260	330	397	453	511	546	576	643	695	737
D	153	88	157	230	292	355	404	459	493	527	591	639	679
E	280	127	141	207	264	321	367	418	452	490	551	594	634
F	433	153	129	190	243	294	340	387	422	460	520	562	599
G	635	202	118	174	223	269	314	357	394	434	491	531	568
H	847	212	108	161	208	250	293	335	373	414	468	506	544
ROUGH													
A	2.6	2.6	232	336	425	493	636	744	821	901	1030	1135	1200
B	16	13.4	204	301	383	449	575	672	742	810	926	1018	1084
C	65	49	177	260	330	397	511	590	663	717	811	890	950
D	153	88	157	230	292	355	459	527	598	647	728	794	845
E	280	127	141	207	264	321	418	480	546	590	669	720	767
F	433	153	129	190	243	294	387	446	506	548	621	664	709
G	635	202	118	174	223	269	357	417	469	509	578	613	656
H	847	212	108	161	208	250	335	395	441	477	541	578	614

Note that no initial mean rainfall depths are required for ellipses I and J because the areas of these ellipses are greater than 1,000 km² which is the areal limit of the DDA curves.

Step 5 Adjusted mean rainfall depth enclosed by each ellipse

Adjust the initial mean rainfall depths for moisture and elevation using the adjustment factors and procedure described in Section 4:

$$AMRD_i = IMRD_i \times MAF \times EAF$$

The adjusted mean rainfall depth for the area enclosed by the outermost ellipse will be equal to the (unrounded) PMP for the whole catchment (Section 4.5).

Step 6 Volume of rainfall enclosed by each ellipse

Multiply the area of the catchment enclosed by each ellipse ($CEnc_i$) (Step 3) by the corresponding adjusted mean rainfall depth for that area ($AMRD_i$) (Step 5) to obtain the volume of rainfall over the catchment and within each ellipse ($VEnc_i$):

$$VEnc_i = AMRD_i \times CEnc_i$$

Step 7 Volume of rainfall between successive ellipses

Obtain the volume of rainfall over the catchment and between successive ellipses ($VBtn_i$) by subtracting the consecutive enclosed volumes ($VEnc_i$) (Step 6):

$$VBtn_i = VEnc_i - VEnc_{i-1}$$

The volume of rainfall within the central ellipse has already been obtained in Step 6.

Step 8 Mean rainfall depth between successive ellipses

Obtain the mean rainfall depth over the catchment and between successive ellipses (MRD_i) by dividing the volume of rainfall between the ellipses ($VBtn_i$) (Step 7) by the catchment area between them ($CBtn_i$) (Step 2):

$$MRDi = \frac{VBtn_i \text{ (Step 7)}}{CBtn_i \text{ (Step 2)}}$$

Step 9 Other PMP Durations

Repeat steps 1 to 8 for other durations.

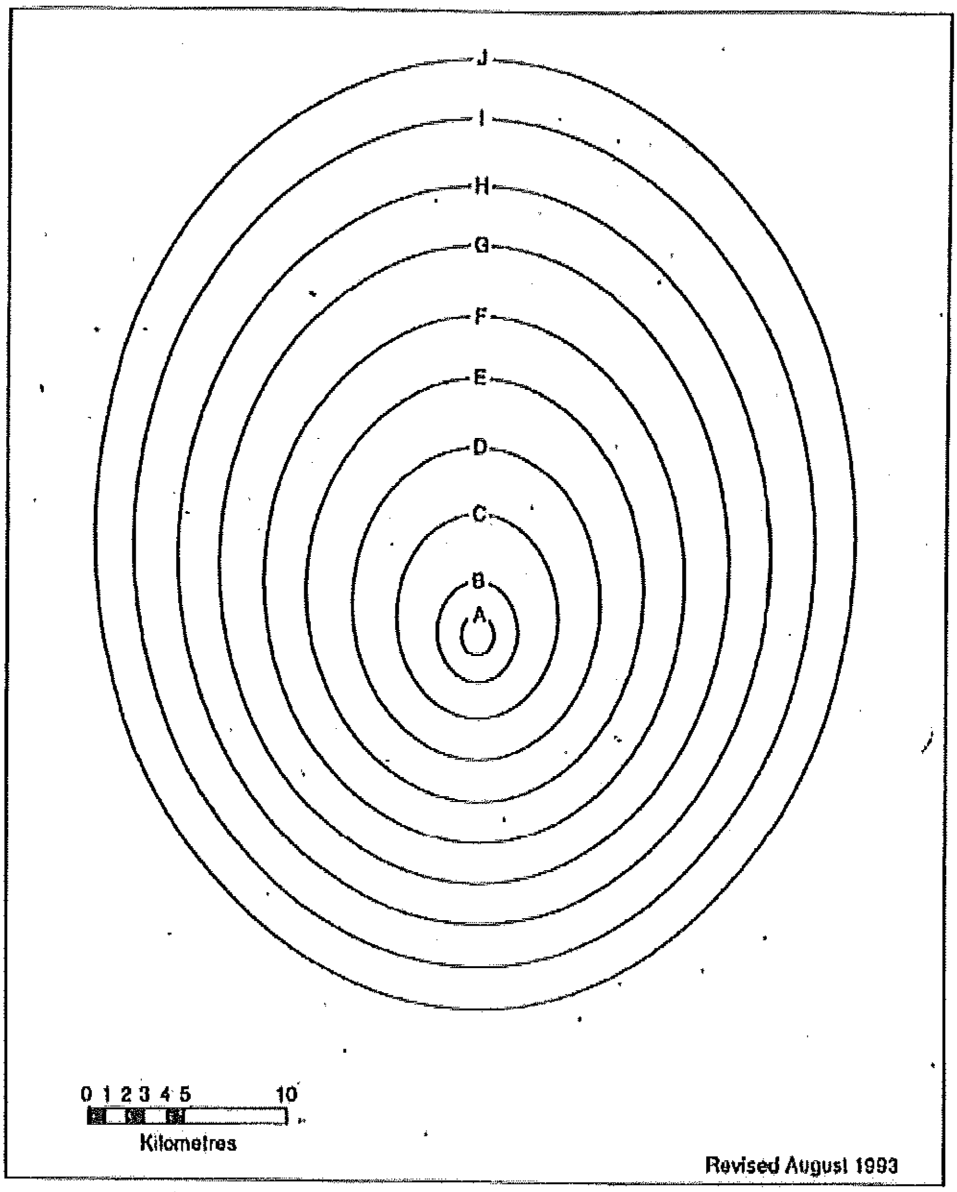


Figure 10 Generalised Short-Duration Method spatial distribution.

5. Design temporal distribution of PMP

A design temporal distribution was derived using pluviograph traces recorded in major Australian storms. This pattern is shown in Table 1 with figures rounded to one per cent and presented as a mass curve in Figure 9.

Table 1 Design temporal distribution of short-duration PMP.

% of time	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
% of PMP	0	4	10	18	25	32	39	46	52	59	64	70	75	80	85	89	92	95	97	99	100

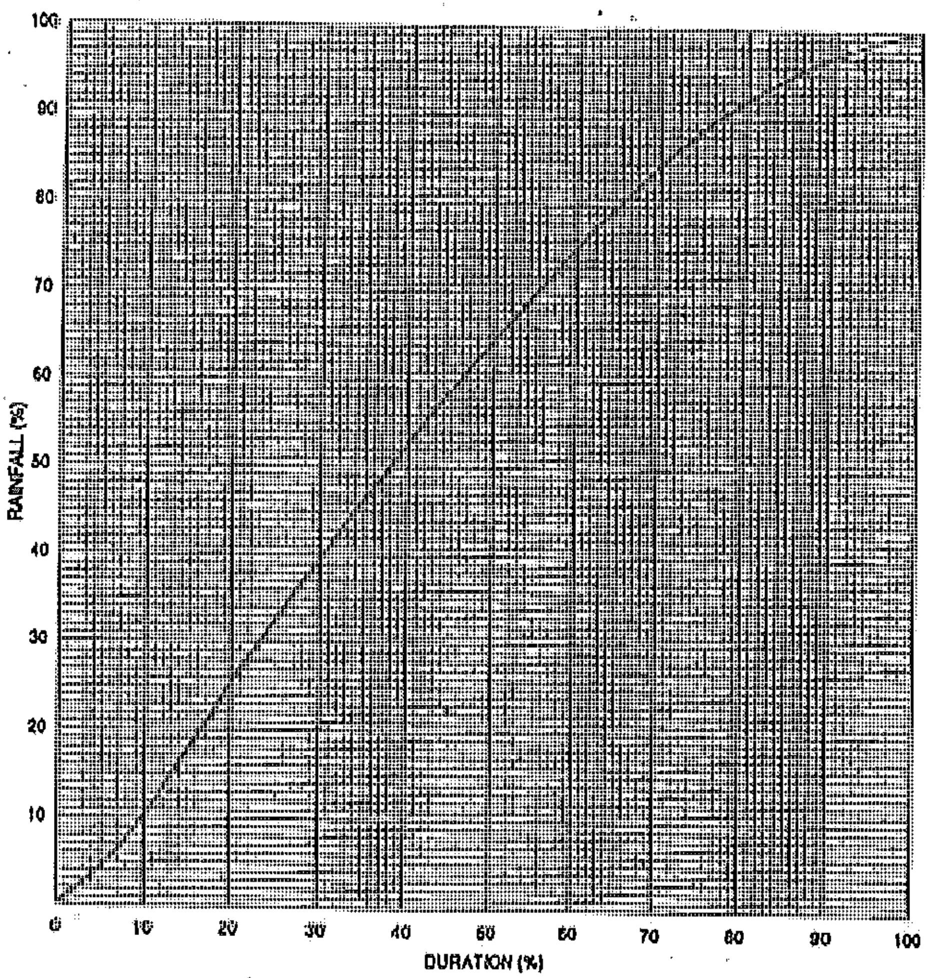


Figure 9 Generalised Short-Duration Method temporal distribution.

Appendix G - Hydraulic Model Results - Existing and Ultimate Catchment Conditions

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
BNE 964170.00	U/S Boundary	1.8	BNE	1.8	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 965390.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 966610.00		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 967010.00		1.9	BNE	1.9	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 967410.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 968600.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 969790.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 970475.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 971160.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 971710.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 972260.00		2.6	BNE	2.6	BNE	0.0	2.3	BNE	2.3	BNE	0.0
BNE 972760.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 973260.00		1.6	BNE	1.6	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 973920.00		1.9	BNE	1.9	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 974580.00		2.5	BNE	2.5	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 975300.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 976020.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 976365.00		1.2	BNE	1.2	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 976750.00		1.3	BNE	1.3	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 977515.00		1.2	BNE	1.2	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 978280.00		1.7	BNE	1.7	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 978853.60		1.7	BNE	1.7	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 979507.00	Kholo Bdg	2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 979510.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 979513.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 979521.50		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 979530.00		1.6	BNE	1.6	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 979930.00		1.5	BNE	1.6	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 980330.00		1.9	BNE	1.9	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 980995.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 981660.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 982060.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 982460.00		1.9	BNE	1.9	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 983310.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 984160.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 984710.00		2.0	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 985260.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 985070.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 986480.00		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 987220.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 987960.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 989060.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 989160.00	Mt Crosby Weir	2.2	BNE	2.2	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 989165.00		4.0	BNE	4.0	BNE	0.0	3.9	BNE	3.9	BNE	0.0
BNE 989170.00		2.2	BNE	2.2	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 989265.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 988360.00		3.4	BNE	2.8	BNE	-0.6	2.5	BNE	2.3	BNE	-0.2
BNE 989030.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 989700.00		1.4	BNE	1.4	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 990200.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 990700.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 990730.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 990760.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 991235.00		1.6	BNE	1.5	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 991710.00		1.2	BNE	1.2	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 992065.00		1.2	BNE	1.2	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 992420.00		1.2	BNE	1.2	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 992435.00		1.4	BNE	1.4	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 992450.00	Colleges Xing	1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 992460.00		1.8	BNE	1.8	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 992470.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 992570.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 992670.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 993215.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 993760.00		2.2	BNE	2.2	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 994260.00		1.7	BNE	1.7	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 994760.00		1.4	BNE	1.4	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 995225.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 995690.00		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 996335.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 996980.00		2.0	BNE	2.0	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 997720.00		1.5	BNE	1.6	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 998460.00		1.2	BNE	1.2	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 998810.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 999160.00		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 999580.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1000000.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1000142.50		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1000285.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1000530.00		2.5	BNE	2.5	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1000775.00		2.6	BNE	2.6	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1001045.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1001315.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1001590.00		2.6	BNE	2.6	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1001865.00		3.3	BNE	3.3	BNE	0.0	2.7	BNE	2.7	BNE	0.0
BNE 1002107.50		3.1	BNE	3.1	BNE	0.0	2.6	BNE	2.6	BNE	0.0
BNE 1002350.00		2.9	BNE	2.9	BNE	0.0	2.5	BNE	2.5	BNE	0.0
BNE 1002567.50		2.5	BNE	2.5	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1002785.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1003030.00		2.5	BNE	2.6	BNE	0.0	2.1	BNE	2.1	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BNE 1003275.00		2.8	BNE	2.8	BNE	0.0	2.4	BNE	2.4	BNE	0.0
BNE 1003525.00		2.7	BNE	2.7	BNE	0.0	2.3	BNE	2.3	BNE	0.0
BNE 1003775.00		2.6	BNE	2.6	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1004037.50		2.9	BNE	2.9	BNE	0.0	2.4	BNE	2.4	BNE	0.0
BNE 1004300.00		3.1	BNE	3.1	BNE	0.0	2.7	BNE	2.7	BNE	0.0
BNE 1004555.00		2.5	BNE	2.5	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1004810.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1005067.50		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1005325.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1005597.50		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1005870.00		2.5	BNE	2.5	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1006035.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1006200.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1006250.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1006300.00	Moggill Gauge	2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1006505.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1006910.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1007160.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1007410.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1007595.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1007780.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1007850.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1007920.00		2.6	BNE	2.6	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1008182.50		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1008445.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1008665.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1008925.00		2.3	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1009162.50		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1009400.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1009560.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1009720.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1010105.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1010490.00		2.7	BNE	2.7	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1010607.50		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1010725.00		2.5	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1010852.50		2.5	BNE	2.5	BNE	0.0	2.0	BNE	1.9	BNE	0.0
BNE 1010990.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1011245.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1011610.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1011745.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1011830.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1012227.50		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1012476.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1012705.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1012935.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013062.50		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013180.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013317.50		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013445.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013562.50		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1013680.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1013795.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1013910.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1014110.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1014310.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1014460.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1014610.00	D/S Boundary	1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1014850.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1015090.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1015325.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1015560.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1015705.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1015850.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1015995.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1016140.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1016350.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1016640.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1016765.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1016890.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1017010.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1017130.00		2.3	BNE	2.3	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1017370.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1017610.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1017785.00		2.1	BNE	2.1	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1017920.00		2.2	BNE	2.2	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1018050.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1018200.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1018462.50		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1018725.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1018910.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1019095.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1019292.50		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1019490.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1019677.50		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1019865.00		2.5	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1019990.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1020115.00		1.6	BNE	1.6	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1020320.00		1.3	BNE	1.3	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1020525.00		1.2	BNE	1.2	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1020677.50		1.4	BNE	1.4	BNE	0.0	1.1	BNE	1.1	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BNE 1020830.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1020952.60		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1021095.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1021317.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1021539.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1021627.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1021715.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1021805.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1021895.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1022000.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1022105.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1022340.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1022576.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1022807.50		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1023040.00		2.6	BNE	2.6	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1023305.00		2.5	BNE	2.6	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1023570.00		2.6	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1023825.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1024080.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1024321.50		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1024563.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1024818.60		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1025070.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1025215.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1025360.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1025475.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1025590.00		2.6	BNE	2.6	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1025880.00		2.5	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1026170.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1026425.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1026580.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1026790.00		2.3	BNE	2.3	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1026900.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1027030.00		2.5	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1027160.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1027420.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1027660.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1027930.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1028150.00		1.8	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1028430.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1028680.00		2.3	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1028720.00		2.9	BNE	2.9	BNE	0.0	2.3	BNE	2.3	BNE	0.0
BNE 1028760.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1028990.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1029200.00		2.5	BNE	2.5	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1029440.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1029690.00		2.2	BNE	2.2	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1029950.00		2.1	BNE	2.1	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1030220.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1030545.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1030870.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1031065.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1031260.00		2.4	BNE	2.4	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1031480.00		2.7	BNE	2.7	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1031700.00		3.0	BNE	3.0	BNE	0.0	2.4	BNE	2.4	BNE	0.0
BNE 1031847.50		2.5	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1031995.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1032112.50		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1032230.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1032407.50		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1032585.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1032832.50		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1033080.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1033225.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1033370.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1033535.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1033900.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1034135.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1034370.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1034630.00		2.5	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1034890.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1035152.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1035414.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1035657.00		2.6	BNE	2.5	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1035900.00		2.7	BNE	2.7	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1036180.00		2.6	BNE	2.6	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1036450.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1036615.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1036770.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1036842.50		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1036915.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1037002.50		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1037090.00		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1037110.00		2.7	BNE	2.7	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1037175.00		2.5	BNE	2.5	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1037230.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1037285.00		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1037455.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1037625.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1037855.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
BNE 1038065.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1038342.50		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1038600.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1038850.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1039100.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1039150.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1039200.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1039392.50		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1039565.00		1.7	BNE	1.7	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1039617.50		1.7	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1039670.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1039749.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1039828.00		1.6	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1039950.00		1.6	BNE	1.6	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1040090.00		1.6	BNE	1.6	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1040170.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1040260.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1040370.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1040490.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1040750.00		1.9	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1041010.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1041120.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1041230.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1041345.00		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1041460.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1041580.00		1.8	BNE	1.8	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1041700.00		1.7	BNE	1.7	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1041830.00		1.9	BNE	1.9	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1041960.00		2.2	BNE	2.2	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1042097.50		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1042235.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1042367.50		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1042500.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1042507.50		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1042515.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1042712.50		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1042910.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1042960.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043010.00		1.9	BNE	1.9	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043045.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043080.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043095.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043110.00		2.0	BNE	2.0	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1043417.50		2.0	BNE	1.9	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1043725.00		1.9	BNE	1.9	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1043892.50		2.0	BNE	2.0	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1044060.00		2.1	BNE	2.1	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1044200.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1044340.00		2.3	BNE	2.3	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1044472.50		2.1	BNE	2.1	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1044605.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1044732.50		1.9	BNE	1.9	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1044860.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1045130.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1045400.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1045642.50		1.8	BNE	1.8	BNE	0.0	1.5	BNE	1.6	BNE	0.0
BNE 1045885.00		1.8	BNE	1.8	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1046032.50		1.7	BNE	1.7	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1046160.00		1.6	BNE	1.6	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1046260.00		1.7	BNE	1.7	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1046340.00		1.7	BNE	1.7	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1046460.00		1.7	BNE	1.7	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1046580.00		1.7	BNE	1.7	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1046740.00		1.9	BNE	1.9	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1046900.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1047125.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1047350.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1047632.50		2.6	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1047915.00		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1048145.00		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1048375.00		1.7	BNE	1.7	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1048632.50		2.0	BNE	2.0	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1048890.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1049005.00		2.2	BNE	2.2	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1049120.00		2.1	BNE	2.1	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1049245.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1049370.00		2.6	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1049480.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1049590.00		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1049730.00		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1049870.00		2.5	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1050150.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.8	BNE	0.0
BNE 1050430.00		2.3	BNE	2.3	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1050645.00		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1050860.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1051110.00		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1051350.00		2.3	BNE	2.3	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1051627.50		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1051895.00		2.8	BNE	2.8	BNE	0.0	2.2	BNE	2.2	BNE	0.0
BNE 1052102.50		2.4	BNE	2.4	BNE	0.0	1.9	BNE	1.9	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
BNE 1052310.00		2.0	BNE	2.1	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1052370.00		3.3	BNE	3.3	BNE	0.0	2.6	BNE	2.6	BNE	0.0
BNE 1052390.00		2.5	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1052492.50		2.6	BNE	2.6	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1052595.00		2.7	BNE	2.7	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1052625.00		4.1	BNE	4.2	BNE	0.1	2.7	BNE	2.7	BNE	0.0
BNE 1052640.00		2.5	BNE	2.5	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1052752.50		2.6	BNE	2.5	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1052865.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1053092.50		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1053320.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1053355.00		2.8	BNE	2.8	BNE	0.0	2.1	BNE	2.1	BNE	0.0
BNE 1053385.00		2.5	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1053842.50		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1053900.00		2.5	BNE	2.5	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1054270.00		1.8	BNE	1.8	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1054640.00		1.4	BNE	1.4	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1054660.00		2.0	BNE	2.0	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1054680.00		1.4	BNE	1.4	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1054825.00		1.8	BNE	1.8	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1054970.00		2.4	BNE	2.4	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1055125.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1055280.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1055350.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1055420.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1055690.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1055960.00		2.1	BNE	2.1	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1056180.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1056400.00		2.7	BNE	2.7	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1056547.50		2.6	BNE	2.6	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1056695.00		2.5	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1056780.00		1.1	BNE	1.1	BNE	0.0	0.7	BNE	0.7	BNE	0.0
BNE 1056865.00		0.7	BNE	0.7	BNE	0.0	0.5	BNE	0.5	BNE	0.0
BNE 1056920.00		2.9	BNE	2.9	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1056950.00		0.7	BNE	0.7	BNE	0.0	0.5	BNE	0.5	BNE	0.0
BNE 1057020.00		1.0	BNE	1.0	BNE	0.0	0.7	BNE	0.7	BNE	0.0
BNE 1057090.00		2.0	BNE	2.0	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1057310.00		2.1	BNE	2.1	BNE	0.0	1.6	BNE	1.5	BNE	0.0
BNE 1057630.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1057765.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1058040.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1058135.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1058230.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1058380.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1058530.00		2.7	BNE	2.7	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1058632.50		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1058735.00		2.4	BNE	2.4	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1058885.00		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1059035.00		2.9	BNE	2.9	BNE	0.0	2.0	BNE	2.0	BNE	0.0
BNE 1059287.50		2.6	BNE	2.5	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1059540.00		2.2	BNE	2.2	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1059765.00		2.2	BNE	2.2	BNE	0.0	1.5	BNE	1.6	BNE	0.0
BNE 1059990.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1060167.50		2.4	BNE	2.4	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1060345.00		2.6	BNE	2.6	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1060440.00		2.7	BNE	2.7	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1060535.00		2.8	BNE	2.8	BNE	0.0	1.9	BNE	1.9	BNE	0.0
BNE 1060775.00		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1061015.00		2.5	BNE	2.6	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1061272.50		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1061530.00		2.7	BNE	2.7	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1061775.00		2.5	BNE	2.6	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1062020.00		2.4	BNE	2.4	BNE	0.0	1.6	BNE	1.6	BNE	0.0
BNE 1062277.50		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.5	BNE	0.0
BNE 1062535.00		2.1	BNE	2.0	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1062737.50		1.8	BNE	1.8	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1062940.00		1.7	BNE	1.7	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1063037.50		1.7	BNE	1.7	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1063125.00		1.8	BNE	1.8	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1063217.50		1.8	BNE	1.8	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1063310.00		1.9	BNE	1.9	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1063477.50		2.2	BNE	2.2	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1063645.00		2.6	BNE	2.6	BNE	0.0	1.8	BNE	1.8	BNE	0.0
BNE 1063822.50		2.5	BNE	2.5	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1064000.00		2.5	BNE	2.5	BNE	0.0	1.7	BNE	1.6	BNE	0.0
BNE 1064245.00		2.5	BNE	2.5	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1064490.00		2.5	BNE	2.5	BNE	0.0	1.7	BNE	1.7	BNE	0.0
BNE 1064750.00		2.2	BNE	2.2	BNE	0.0	1.6	BNE	1.5	BNE	0.0
BNE 1065010.00		2.0	BNE	2.0	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1065256.50		1.9	BNE	1.9	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1065503.00		1.9	BNE	1.9	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1065746.50		1.6	BNE	1.6	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1065990.00		1.4	BNE	1.4	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1066247.50		1.6	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1066505.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1066762.50		1.6	BNE	1.6	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1067020.00		1.6	BNE	1.6	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1067252.50		1.7	BNE	1.7	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1067485.00		1.9	BNE	1.9	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1067725.00		2.0	BNE	2.0	BNE	0.0	1.3	BNE	1.3	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

[illegible] Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
BNE 1067955.00		2.1	BNE	2.1	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1068312.50		2.1	BNE	2.1	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1068660.00		2.2	BNE	2.2	BNE	0.0	1.5	BNE	1.5	BNE	0.0
BNE 1068852.50		2.2	BNE	2.2	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1069045.00		2.2	BNE	2.2	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1069290.00		2.1	BNE	2.1	BNE	0.0	1.4	BNE	1.4	BNE	0.0
BNE 1069535.00		2.0	BNE	2.0	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1069760.00		2.0	BNE	2.0	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1070025.00		1.9	BNE	1.9	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1070277.50		1.9	BNE	1.9	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1070530.00		2.0	BNE	2.0	BNE	0.0	1.3	BNE	1.3	BNE	0.0
BNE 1070765.00		1.9	BNE	1.9	BNE	0.0	1.3	BNE	1.2	BNE	0.0
BNE 1071040.00		1.9	BNE	1.9	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1071280.00		1.6	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1071520.00		1.4	BNE	1.4	BNE	0.0	0.9	BNE	0.9	BNE	0.0
BNE 1071767.50		1.6	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1072015.00		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072017.50		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072020.00		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072267.50		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072515.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072755.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1072995.00		1.6	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1073240.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1073485.00		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1073742.50		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1074000.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1074230.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1074460.00		1.7	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1074722.50		1.8	BNE	1.8	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1074985.00		1.9	BNE	1.9	BNE	0.0	1.2	BNE	1.2	BNE	0.0
BNE 1075232.50		1.8	BNE	1.7	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BNE 1075480.00		1.6	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1075740.00		1.3	BNE	1.3	BNE	0.0	0.8	BNE	0.8	BNE	0.0
BNE 1076000.00		1.2	BNE	1.2	BNE	0.0	0.7	BNE	0.7	BNE	0.0
BNE 1076247.50		1.3	BNE	1.3	BNE	0.0	0.8	BNE	0.8	BNE	0.0
BNE 1076495.00		1.5	BNE	1.6	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BNE 1076752.50		1.3	BNE	1.3	BNE	0.0	0.8	BNE	0.8	BNE	0.0
BNE 1077010.00		1.1	BNE	1.1	BNE	0.0	0.7	BNE	0.7	BNE	0.0
BNE 1077260.00		0.9	BNE	0.9	BNE	0.0	0.6	BNE	0.6	BNE	0.0
BNE 1077510.00		0.8	BNE	0.8	BNE	0.0	0.5	BNE	0.5	BNE	0.0
BNE 1077775.00		0.8	BNE	0.8	BNE	0.0	0.6	BNE	0.5	BNE	0.0
BNE 1078040.00		0.8	BNE	0.8	BNE	0.0	0.6	BNE	0.5	BNE	0.0
BNE 1078282.50		1.0	BNE	1.0	BNE	0.0	0.6	BNE	0.6	BNE	0.0
BNE 1078525.00		1.3	BNE	1.3	BNE	0.0	0.8	BNE	0.8	BNE	0.0
BNE 1078592.50		0.3	BNE	0.3	BNE	0.0	0.2	BNE	0.2	BNE	0.0
BNE 1078660.00		0.2	BNE	0.2	BNE	0.0	0.1	BNE	0.1	BNE	0.0
BREM 1000000.00	U/S Boundary	1.0	BREM	0.9	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BREM 1000350.00		1.0	BREM	1.1	BNE	0.0	1.0	BNE	1.0	BREM	0.0
BREM 1000700.00		0.7	BNE	0.7	BNE	0.0	0.7	BNE	0.7	BNE	0.0
BREM 1000910.00		1.0	BREM	1.2	BNE	0.2	0.9	BNE	1.2	BNE	0.3
BREM 1001120.00		0.6	BREM	0.5	BREM	0.0	0.6	BREM	0.5	BREM	-0.1
BREM 1001410.00		0.9	BNE	0.9	BREM	0.0	0.9	BNE	0.9	BNE	0.0
BREM 1001700.00		1.1	BNE	1.1	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BREM 1002000.00		1.2	BNE	1.2	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1002350.00		1.0	BNE	1.0	BREM	0.0	0.9	BNE	0.9	BNE	0.0
BREM 1002500.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1002700.00		1.3	BNE	1.3	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1002916.00		1.4	BREM	1.4	BREM	0.0	1.3	BNE	1.2	BREM	0.0
BREM 1003130.00		1.3	BREM	1.3	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1003165.00		1.3	BREM	1.3	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1003200.00		1.2	BREM	1.2	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1003450.00		1.2	BREM	1.2	BREM	0.0	1.1	BREM	1.1	BNE	0.0
BREM 1003700.00		1.6	BNE	1.6	BNE	0.1	1.5	BNE	1.6	BNE	0.1
BREM 1003770.00		1.4	BNE	1.5	BNE	0.1	1.4	BNE	1.5	BNE	0.1
BREM 1003840.00		1.3	BREM	1.4	BNE	0.1	1.3	BNE	1.3	BNE	0.1
BREM 1003995.00		1.1	BNE	1.1	BREM	0.0	1.0	BREM	1.1	BNE	0.0
BREM 1004150.00		1.1	BNE	1.1	BREM	0.0	1.0	BREM	1.0	BREM	0.0
BREM 1004235.00		1.2	BREM	1.2	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1004320.00		1.4	BREM	1.4	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1004455.00		1.6	BNE	1.4	BNE	0.0	1.4	BNE	1.3	BNE	0.0
BREM 1004590.00	One Mile Bdg	1.7	BNE	1.7	BNE	-0.1	1.6	BNE	1.6	BNE	0.0
BREM 1004600.00		2.5	BNE	2.4	BNE	-0.1	2.4	BNE	2.3	BNE	0.0
BREM 1004610.00		1.6	BNE	1.7	BNE	-0.1	1.7	BNE	1.7	BNE	0.0
BREM 1004630.00		1.6	BREM	1.6	BNE	-0.1	1.5	BNE	1.5	BNE	0.0
BREM 1004650.00		1.5	BREM	1.4	BNE	-0.1	1.4	BNE	1.4	BREM	0.0
BREM 1004675.00		1.6	BNE	1.7	BNE	0.2	1.6	BNE	1.6	BNE	0.1
BREM 1004700.00		1.6	BNE	1.7	BNE	0.2	1.6	BNE	1.6	BNE	0.1
BREM 1004920.00		1.2	BREM	1.3	BNE	0.1	1.1	BNE	1.2	BNE	0.1
BREM 1005140.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1005330.00		1.8	BREM	1.8	BREM	0.0	1.5	BNE	1.5	BNE	0.0
BREM 1005520.00		2.6	BREM	2.6	BREM	0.0	1.9	BNE	1.9	BNE	0.0
BREM 1005630.00		1.7	BREM	1.6	BREM	0.0	1.4	BNE	1.4	BNE	0.0
BREM 1005740.00		1.2	BREM	1.2	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1005915.00		1.7	BREM	1.7	BREM	0.0	1.5	BNE	1.5	BNE	0.0
BREM 1006090.00		2.8	BREM	2.7	BREM	0.0	2.2	BNE	2.2	BNE	0.0
BREM 1006170.00		1.9	BREM	1.9	BREM	0.0	1.6	BNE	1.6	BNE	0.0
BREM 1006250.00		1.5	BREM	1.5	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1006370.00		1.7	BREM	1.7	BREM	0.0	1.4	BNE	1.4	BNE	0.0
BREM 1006460.00	Wukaraka Bdg	2.1	BREM	2.1	BREM	0.0	1.8	BNE	1.8	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BREM 1006500.00		2.2	BREM	2.3	BREM	0.1	1.9	BNE	1.9	BREM	0.0
BREM 1006610.00		2.1	BREM	2.1	BREM	0.0	1.9	BNE	1.8	BNE	0.0
BREM 1006645.00		1.6	BREM	1.6	BREM	0.0	1.4	BNE	1.5	BNE	0.1
BREM 1006780.00		1.3	BREM	1.4	BNE	0.1	1.3	BNE	1.4	BNE	0.1
BREM 1007110.00		1.8	BREM	1.8	BREM	0.0	1.6	BNE	1.5	BNE	0.0
BREM 1007440.00		3.0	BREM	3.0	BREM	0.0	2.3	BNE	2.3	BNE	0.0
BREM 1007570.00		2.2	BREM	2.2	BREM	0.0	1.8	BNE	1.8	BNE	0.0
BREM 1007700.00		1.7	BREM	1.7	BREM	0.0	1.6	BNE	1.5	BNE	0.0
BREM 1007850.00		1.9	BREM	1.9	BREM	0.0	1.5	BNE	1.5	BNE	0.0
BREM 1008000.00		2.1	BREM	2.1	BREM	0.0	1.6	BNE	1.6	BNE	0.0
BREM 1008195.00		1.6	BREM	1.6	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1008390.00	Hancock Bdg	1.4	BREM	1.3	BNE	0.0	1.3	BNE	1.3	BREM	0.0
BREM 1008400.00		2.1	BREM	2.1	BREM	0.0	2.0	BREM	2.0	BREM	0.0
BREM 1008410.00		1.4	BREM	1.4	BNE	0.0	1.3	BNE	1.3	BREM	0.0
BREM 1008415.00		1.6	BREM	1.6	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1008420.00		1.8	BREM	1.8	BREM	0.0	1.6	BNE	1.6	BNE	0.0
BREM 1008540.00		2.0	BREM	2.0	BREM	0.0	1.7	BNE	1.7	BNE	0.0
BREM 1008660.00		2.2	BREM	2.2	BREM	0.0	1.8	BNE	1.8	BNE	0.0
BREM 1008935.00		2.1	BREM	2.1	BREM	0.0	1.7	BNE	1.7	BNE	0.0
BREM 1009210.00		1.9	BREM	1.9	BREM	0.0	1.6	BNE	1.6	BNE	0.0
BREM 1009397.50		1.7	BREM	1.7	BREM	0.0	1.4	BNE	1.4	BNE	0.0
BREM 1009585.00		1.5	BREM	1.5	BREM	0.0	1.3	BNE	1.3	BNE	0.0
BREM 1009630.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1009675.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1009747.50		1.2	BREM	1.3	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1009820.00		1.4	BREM	1.4	BREM	0.0	1.5	BREM	1.3	BREM	0.0
BREM 1009920.00		1.7	BREM	1.7	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1010020.00		2.4	BREM	2.3	BREM	0.0	1.8	BNE	1.8	BNE	0.0
BREM 1010150.00		1.8	BREM	1.8	BREM	0.0	1.4	BNE	1.4	BNE	0.0
BREM 1010280.00		1.4	BREM	1.4	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1010490.00		1.6	BREM	1.6	BREM	0.0	1.3	BNE	1.3	BNE	0.0
BREM 1010700.00		1.8	BREM	1.8	BREM	0.0	1.4	BNE	1.4	BNE	0.0
BREM 1010795.00		2.0	BREM	2.0	BREM	0.0	1.6	BNE	1.5	BNE	0.0
BREM 1010890.00		2.2	BREM	2.2	BREM	0.0	1.7	BNE	1.7	BNE	0.0
BREM 1011105.00		1.7	BREM	1.7	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1011320.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BREM 1011510.00		1.8	BREM	1.8	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1011700.00		2.5	BREM	2.6	BREM	0.0	1.9	BNE	1.9	BNE	0.0
BREM 1011745.00		2.3	BREM	2.3	BREM	0.0	1.8	BREM	1.8	BNE	0.0
BREM 1011790.00	Railway Workshops Bdg	2.1	BREM	2.1	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1011800.00		2.4	BREM	2.4	BREM	0.0	1.8	BREM	1.9	BREM	0.0
BREM 1011810.00		2.1	BREM	2.1	BREM	0.0	1.7	BREM	1.8	BREM	0.0
BREM 1011830.00		1.8	BREM	1.8	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1012050.00	David Trumpy Bdg	1.5	BREM	1.5	BREM	0.0	1.2	BREM	1.2	BNE	0.0
BREM 1012060.00		1.8	BREM	1.8	BREM	0.0	1.5	BNE	1.6	BNE	0.1
BREM 1012070.00		1.5	BREM	1.6	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1012135.00		1.8	BREM	1.6	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1012200.00		2.1	BREM	2.1	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1012535.00		1.7	BREM	1.7	BREM	0.0	1.3	BNE	1.3	BNE	0.0
BREM 1012870.00		1.4	BREM	1.4	BREM	0.0	1.0	BNE	1.0	BNE	0.0
BREM 1013125.00		1.4	BREM	1.4	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1013380.00		1.5	BREM	1.6	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1013540.00		1.4	BREM	1.4	BNE	0.0	1.3	BREM	1.3	BNE	0.0
BREM 1013700.00		1.3	BREM	1.4	BNE	0.0	1.2	BNE	1.3	BNE	0.1
BREM 1013960.00		1.7	BREM	1.8	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1014220.00		2.3	BREM	2.2	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1014430.00		2.2	BREM	2.2	BREM	0.0	1.7	BNE	1.6	BREM	0.0
BREM 1014640.00		2.2	BREM	2.2	BREM	0.0	1.6	BNE	1.6	BNE	0.0
BREM 1014910.00		2.3	BREM	2.2	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1015180.00		2.3	BREM	2.3	BREM	0.0	1.8	BREM	1.8	BREM	0.0
BREM 1015312.50		2.0	BREM	1.9	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1015445.00		1.7	BREM	1.7	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1015577.50		1.6	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1015710.00		1.3	BREM	1.3	BREM	0.0	1.2	BNE	1.2	BREM	0.0
BREM 1015910.00		1.4	BREM	1.4	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1016110.00		1.4	BREM	1.4	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1016310.00		1.4	BREM	1.4	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1016510.00		1.5	BREM	1.5	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1016795.00		1.6	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1017080.00		1.8	BREM	1.7	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1017415.00		1.4	BREM	1.4	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1017760.00		1.2	BREM	1.2	BREM	0.0	1.1	BREM	1.0	BNE	0.0
BREM 1017945.00		1.4	BREM	1.4	BREM	0.0	1.2	BNE	1.1	BREM	0.0
BREM 1018140.00		1.6	BREM	1.6	BREM	0.0	1.3	BNE	1.2	BREM	-0.1
BREM 1018230.00		1.6	BREM	1.6	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1018320.00		1.6	BREM	1.6	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1018410.00		1.6	BREM	1.6	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1018500.00		1.6	BREM	1.6	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1018565.00		1.5	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1018630.00		1.5	BREM	1.5	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1018695.00		1.6	BREM	1.6	BREM	0.0	1.5	BREM	1.5	BREM	0.0
BREM 1018760.00		1.7	BREM	1.7	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1018955.00		1.4	BREM	1.4	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1019150.00		1.1	BREM	1.1	BREM	0.0	1.0	BREM	1.0	BREM	0.0
BREM 1019355.00		1.2	BREM	1.2	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1019560.00		1.4	BREM	1.4	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1019760.00		1.5	BREM	1.4	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1020000.00		1.6	BREM	1.5	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1020150.00		1.1	BREM	1.1	BREM	0.0	1.0	BREM	1.0	BREM	0.0
BREM 1020300.00		0.9	BREM	0.9	BREM	0.0	0.8	BNE	0.8	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BREM 1020370.00		0.9	BREM	0.9	BNE	0.0	0.9	BREM	0.9	BNE	0.0
BREM 1020440.00		0.9	BREM	0.9	BNE	0.0	0.8	BREM	0.9	BNE	0.0
BREM 1020445.00		0.9	BREM	0.9	BNE	0.0	0.8	BREM	0.9	BNE	0.0
BREM 1020450.00		0.8	BREM	0.8	BNE	0.0	0.8	BREM	0.8	BNE	0.0
BREM 1020475.00		0.7	BREM	0.7	BREM	0.0	0.7	BNE	0.7	BNE	0.0
BREM 1020500.00		0.7	BREM	0.7	BREM	0.0	0.7	BNE	0.7	BNE	0.0
BREM 1020710.00		0.9	BREM	0.9	BREM	0.0	0.8	BREM	0.8	BREM	0.0
BREM 1020920.00		1.2	BREM	1.2	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1021190.00		1.2	BREM	1.3	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1021460.00		1.3	BREM	1.3	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1021880.00		1.4	BREM	1.4	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1022300.00		1.4	BREM	1.4	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1022625.00		1.2	BREM	1.2	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1022950.00		1.0	BREM	1.0	BREM	0.0	1.0	BREM	1.0	BREM	0.0
BREM 1023220.00		1.1	BREM	1.1	BREM	0.0	1.1	BREM	1.1	BREM	0.0
BREM 1023490.00	Warrego Hway Bdg	1.7	BREM	1.7	BREM	0.0	1.5	BREM	1.5	BREM	0.0
BREM 1023500.00		1.8	BREM	1.8	BREM	0.0	1.8	BREM	1.6	BREM	0.0
BREM 1023510.00		1.8	BREM	1.7	BREM	0.0	1.5	BREM	1.6	BREM	0.0
BREM 1023600.00		1.6	BREM	1.5	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1023870.00		1.3	BREM	1.3	BREM	0.0	1.2	BREM	1.2	BREM	0.0
BREM 1024045.00		1.6	BREM	1.5	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1024220.00		2.0	BREM	2.0	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1024370.00		1.6	BREM	1.6	BREM	0.0	1.5	BREM	1.5	BREM	0.0
BREM 1024520.00		1.4	BREM	1.4	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1024535.00		1.5	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1024760.00		1.6	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1025025.00		1.6	BREM	1.6	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1025300.00		1.7	BREM	1.7	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BREM 1025465.00		1.7	BREM	1.7	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1025670.00		1.7	BREM	1.7	BREM	0.0	1.5	BREM	1.5	BREM	0.0
BREM 1025795.00		1.8	BREM	1.6	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1025920.00		1.9	BREM	1.9	BREM	0.0	1.6	BREM	1.6	BREM	0.0
BREM 1026035.00		1.9	BREM	1.8	BREM	0.0	1.5	BREM	1.5	BREM	0.0
BREM 1026150.00		1.8	BREM	1.8	BREM	0.0	1.4	BREM	1.4	BREM	0.0
BREM 1026355.00		1.9	BREM	1.8	BREM	0.0	1.6	BREM	1.5	BREM	0.0
BREM 1026560.00		2.0	BREM	2.0	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1026930.00		2.1	BREM	2.1	BREM	0.0	1.7	BREM	1.7	BREM	0.0
BREM 1027100.00		2.2	BREM	2.2	BREM	0.0	1.8	BREM	1.8	BREM	0.0
BREM 1027370.00		2.3	BREM	2.3	BREM	0.0	1.8	BREM	1.8	BREM	0.0
BREM 1027640.00		2.4	BREM	2.3	BREM	0.0	1.8	BREM	1.8	BREM	0.0
BREM 1027740.00		2.5	BREM	2.5	BREM	0.0	1.9	BREM	1.9	BREM	0.0
BREM 1027840.00		2.7	BREM	2.6	BREM	0.0	2.0	BREM	1.9	BREM	0.0
BREM 1028015.00		2.9	BREM	2.9	BREM	0.0	2.2	BREM	2.1	BREM	0.0
BREM 1028100.00		3.3	BREM	3.2	BREM	0.0	2.4	BREM	2.4	BREM	0.0
BREM 1028340.00		3.0	BREM	3.0	BREM	0.0	2.4	BREM	2.3	BREM	0.0
BREM 1028490.00		2.9	BREM	2.9	BREM	0.0	2.3	BREM	2.3	BREM	0.0
OXLEY 699400.00		2.9	BNE	2.8	BNE	0.0	2.3	BNE	2.3	BNE	0.0
OXLEY 699700.00		0.5	BNE	0.6	BNE	0.0	0.4	BNE	0.4	BNE	0.0
OXLEY 600000.00		0.3	BNE	0.3	BNE	0.0	0.2	BNE	0.2	BNE	0.0
BREAKFAST 699400.00		357.2	BNE	357.2	BNE	0.0	321.7	BNE	321.7	BNE	0.0
BREAKFAST 699700.00		0.2	BNE	0.2	BNE	0.0	0.1	BNE	0.1	BNE	0.0
BREAKFAST 600000.00		0.1	BNE	0.1	BNE	0.0	0.1	BNE	0.1	BNE	0.0
BULIMBA 699400.00		1.4	BNE	1.4	BNE	0.0	1.0	BNE	1.0	BNE	0.0
BULIMBA 699700.00		0.3	BNE	0.3	BNE	0.0	0.3	BNE	0.3	BNE	0.0
BULIMBA 600000.00		0.2	OFEB	0.2	SIX	0.0	0.2	SIX	0.2	BREM	0.0
GOODNALINK1 0.00		21.6	BNE	20.9	BNE	-0.7	0.0	GOOD	0.0	BNE	0.0
GOODNALINK1 500.00		1.4	BNE	1.4	BNE	0.0	0.0	0.0	0.0	0.0	0.0
GOODNALINK1 1000.00		21.6	BNE	20.9	BNE	-0.7	0.0	GOOD	0.0	0.0	0.0
GOODNALINK2 0.00		14.8	BNE	14.5	BNE	-0.3	0.1	GOOD	0.0	BNE	-0.1
GOODNALINK2 535.00		1.8	BNE	1.8	BNE	0.0	0.0	0.0	0.0	0.0	0.0
GOODNALINK2 1070.00		14.8	BNE	14.5	BNE	-0.3	0.0	GOOD	0.0	0.0	0.0
STLUCIALINK1 0.00		98.1	BNE	97.8	BNE	-0.3	0.0	BREM	0.0	BREM	0.0
STLUCIALINK1 525.00		3.6	BNE	3.5	BNE	0.0	0.0	0.0	0.0	0.0	0.0
STLUCIALINK1 1050.00		98.1	BNE	97.8	BNE	-0.3	0.0	0.0	0.0	0.0	0.0
STLUCIALINK2 0.00		63.7	BNE	62.5	BNE	-1.2	0.0	BNE	0.0	BNE	0.0
STLUCIALINK2 525.00		2.4	BNE	2.4	BNE	0.0	0.0	0.0	0.0	0.0	0.0
STLUCIALINK2 1050.00		63.7	BNE	62.5	BNE	-1.2	0.0	0.0	0.0	0.0	0.0
STLUCIALINK3 0.00		26.9	BNE	25.6	BNE	-1.3	0.0	BNE	0.0	BNE	0.0
STLUCIALINK3 425.00		2.1	BNE	2.1	BNE	0.0	0.0	0.0	0.0	0.0	0.0
STLUCIALINK3 850.00		26.9	BNE	25.6	BNE	-1.3	0.0	0.0	0.0	0.0	0.0
SIX 9530.00		1.4	BNE	1.4	BNE	0.0	1.3	BNE	1.3	BNE	0.0
SIX 9662.50		1.7	SIX	1.7	SIX	0.0	1.5	SIX	1.5	SIX	0.0
SIX 9795.00		1.7	BNE	1.7	BNE	0.0	1.6	BNE	1.6	BNE	0.0
SIX 9927.50		2.3	SIX	2.3	SIX	0.0	2.1	SIX	2.1	SIX	0.0
SIX 10060.00		2.6	BNE	2.7	BNE	0.0	2.5	BNE	2.5	BNE	0.0
SIX 10185.00		1.9	SIX	2.0	SIX	0.0	1.7	SIX	1.7	SIX	0.0
SIX 10310.00		1.1	BNE	1.1	BNE	0.0	1.0	BNE	1.1	BNE	0.0
SIX 10337.50		1.4	SIX	1.4	SIX	0.0	1.2	SIX	1.2	SIX	0.0
SIX 10365.00	Halets Rd xing	1.2	BNE	1.2	BNE	0.0	1.1	BNE	1.2	BNE	0.1
SIX 10377.00		2.7	SIX	2.8	SIX	0.2	2.2	SIX	2.4	BNE	0.2
SIX 10380.00		1.8	SIX	1.7	SIX	0.0	1.5	SIX	1.5	SIX	0.0
SIX 10420.00		1.9	SIX	1.9	SIX	0.0	1.5	SIX	1.5	SIX	0.0
SIX 10460.00		1.6	SIX	2.0	BNE	0.4	1.3	BNE	1.8	BNE	0.6
SIX 10690.00		1.7	SIX	1.7	SIX	0.0	1.5	SIX	1.5	SIX	0.0
SIX 10920.00		1.5	BNE	1.6	BNE	0.0	1.4	BNE	1.4	BNE	0.0
SIX 11137.50		2.3	SIX	2.3	SIX	0.0	2.0	SIX	2.0	SIX	0.0
SIX 11355.00		2.9	BNE	2.8	BNE	-0.1	2.7	BNE	2.6	BNE	-0.1
SIX 11462.50		1.6	SIX	1.6	BNE	0.0	1.6	SIX	1.6	SIX	0.0
SIX 11570.00		1.7	BNE	1.8	BNE	0.0	1.7	BNE	1.8	BNE	0.0
SIX 11620.00		1.8	BNE	1.9	BNE	0.1	1.7	SIX	1.8	BNE	0.1

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
SIX 11670.00		1.9	BNE	2.0	BNE	0.0	1.8	BNE	1.9	BNE	0.1
SIX 11720.00		1.1	BNE	1.1	BNE	0.0	1.1	BNE	1.1	BNE	0.0
SIX 11770.00	Redbank Plains Rd Bdg	0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
SIX 11785.00		2.7	BNE	2.6	BNE	0.0	2.7	SIX	2.7	BNE	0.0
SIX 11800.00		0.9	BNE	0.8	BNE	0.0	0.8	BNE	0.7	BNE	-0.1
SIX 11835.00		1.1	SIX	1.1	SIX	0.0	1.0	SIX	1.0	SIX	0.0
SIX 11870.00		1.8	BNE	1.9	BNE	0.1	1.6	BNE	1.8	BNE	0.2
SIX 11940.00		1.7	BNE	2.1	BNE	0.4	1.7	SIX	1.7	BNE	0.0
SIX 12010.00		2.8	BNE	3.6	BNE	0.8	2.3	BNE	2.8	BNE	0.5
SIX 12240.00		1.1	SIX	1.1	SIX	0.0	1.0	SIX	0.9	SIX	0.0
SIX 12470.00		1.2	BNE	1.1	BNE	-0.1	1.1	BNE	1.0	BNE	-0.1
SIX 12720.00		1.0	SIX	1.0	SIX	0.0	0.9	BNE	0.9	SIX	0.0
SIX 12970.00		0.9	BNE	0.9	BNE	0.0	0.9	BNE	0.9	BNE	0.0
SIX 13132.50		1.0	BNE	1.0	SIX	0.0	1.0	BNE	1.0	SIX	0.0
SIX 13285.00		1.6	BNE	1.8	BNE	0.4	1.4	BNE	1.7	BNE	0.3
SIX 13457.50		1.0	BNE	1.1	SIX	0.1	1.0	BNE	1.0	SIX	0.0
SIX 13620.00		1.4	BNE	1.4	BNE	0.0	1.4	BNE	1.4	BNE	0.0
SIX 13932.50		1.0	SIX	1.1	SIX	0.0	1.0	BNE	1.0	SIX	0.0
SIX 14045.00		1.0	BNE	0.9	BNE	-0.1	0.9	BNE	0.9	BNE	0.0
SIX 14257.50		0.9	SIX	0.9	SIX	0.1	0.8	SIX	0.8	SIX	0.0
SIX 14470.00		0.7	BNE	0.7	BNE	0.0	0.7	BNE	0.7	BNE	0.0
SIX 14635.00		1.0	SIX	1.0	BNE	0.0	1.0	SIX	1.0	SIX	0.0
SIX 14800.00		2.7	BNE	2.7	BNE	0.0	2.7	BNE	2.7	BNE	0.0
SIX 14985.00		0.8	SIX	0.9	SIX	0.1	0.9	BNE	0.9	BNE	0.0
SIX 15170.00		0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
SIX 15370.00		0.6	SIX	0.7	SIX	0.0	0.6	SIX	0.6	SIX	0.0
SIX 15570.00		0.6	BNE	0.5	SIX	-0.1	0.5	BNE	0.5	BNE	-0.1
SIX 15740.00		0.7	SIX	0.7	SIX	0.0	0.5	SIX	0.5	SIX	0.0
SIX 15910.00		0.6	SIX	0.6	SIX	0.0	0.5	BNE	0.5	SIX	0.0
SIX 16090.00		0.8	SIX	0.9	SIX	0.0	0.7	SIX	0.7	SIX	0.0
SIX 16270.00		1.2	BNE	1.1	BNE	-0.1	1.1	BNE	1.1	BNE	0.0
SIX 16370.00		1.9	SIX	1.9	SIX	0.0	1.7	SIX	1.7	SIX	0.0
SIX 16470.00		3.7	BNE	3.6	SIX	-0.1	3.3	BNE	3.1	SIX	-0.2
SIX 16595.00		2.5	SIX	2.6	SIX	0.0	2.2	SIX	2.2	SIX	0.0
SIX 16720.00		1.7	BNE	1.6	SIX	-0.1	1.6	BNE	1.5	SIX	-0.1
SIX 16930.00		1.4	SIX	1.4	SIX	0.0	1.3	SIX	1.3	SIX	0.0
SIX 17140.00		1.0	BNE	1.0	BNE	0.0	1.0	BNE	1.0	BNE	0.0
SIX 17205.00		1.5	SIX	1.5	SIX	0.0	1.3	SIX	1.3	SIX	0.0
SIX 17270.00		2.2	SIX	2.1	SIX	0.0	1.8	BNE	1.8	SIX	-0.1
SIX 17400.00		2.2	SIX	2.1	SIX	0.0	1.8	SIX	1.8	SIX	0.0
SIX 17530.00		1.6	SIX	1.6	SIX	0.0	1.6	BNE	1.5	SIX	-0.1
SIX 17730.00		1.7	SIX	1.7	SIX	0.0	1.4	SIX	1.4	SIX	0.0
SIX 17930.00		1.3	BNE	1.3	SIX	-0.1	1.2	BNE	1.2	BNE	0.0
SIX 18100.00		1.6	SIX	1.6	SIX	0.0	1.4	SIX	1.4	SIX	0.0
SIX 18270.00		1.9	BNE	1.9	BNE	0.0	1.8	BNE	1.8	BNE	0.0
SIX 18495.00		1.7	SIX	1.7	SIX	0.0	1.6	SIX	1.6	SIX	0.0
SIX 18720.00		1.8	BNE	1.8	BNE	0.0	1.8	BNE	1.8	BNE	0.0
SIX 18845.00		1.8	SIX	1.8	SIX	0.0	1.7	SIX	1.7	SIX	0.0
SIX 18970.00		2.2	BNE	2.1	BNE	-0.1	2.1	BNE	1.9	BNE	-0.1
SIX 19070.00		1.6	SIX	1.6	SIX	0.0	1.6	BNE	1.6	SIX	0.0
SIX 19170.00		1.3	SIX	1.3	SIX	0.0	1.4	BNE	1.4	BNE	0.0
SIX 19270.00		1.6	SIX	1.6	SIX	0.0	1.6	SIX	1.6	SIX	0.0
SIX 19370.00		2.0	BNE	2.0	BNE	0.0	2.0	BNE	1.9	BNE	-0.1
SIX 19510.00		2.0	SIX	2.0	SIX	0.0	1.9	SIX	1.9	SIX	0.0
SIX 19650.00		1.7	BNE	1.7	BNE	0.0	1.7	BNE	1.7	BNE	0.0
SIX 19720.00		1.9	SIX	1.8	SIX	0.0	1.8	SIX	1.8	SIX	0.0
SIX 19790.00		1.8	SIX	1.7	SIX	-0.1	1.6	BNE	1.6	BNE	-0.1
SIX 19850.00	Ipswich Rd Bdg	3.8	SIX	3.9	SIX	0.0	4.6	SIX	3.6	SIX	-1.0
SIX 19870.00		2.7	SIX	2.7	SIX	0.0	2.6	SIX	2.6	SIX	0.0
SIX 19935.00		2.3	SIX	2.3	SIX	0.0	2.2	SIX	2.2	SIX	0.0
SIX 20000.00		1.8	BNE	1.8	SIX	0.0	1.7	SIX	1.7	SIX	0.0
SIX 20070.00		2.1	SIX	2.1	SIX	0.0	2.0	SIX	2.0	SIX	0.0
SIX 20140.00	Bris-Ips Rail Bdg	2.2	BNE	2.1	SIX	-0.1	1.9	SIX	2.0	SIX	0.0
SIX 20150.00		6.2	SIX	6.2	SIX	-0.1	4.6	SIX	4.6	SIX	0.0
SIX 20160.00		4.4	SIX	4.4	SIX	0.0	3.3	SIX	3.4	SIX	0.0
SIX 20197.50		6.8	SIX	7.2	SIX	0.4	4.7	SIX	4.9	SIX	0.2
SIX 20235.00		14.6	SIX	17.0	SIX	2.4	8.3	SIX	8.6	SIX	0.3
GOOD 10000.00		1.7	GOOD	1.8	GOOD	0.1	1.6	GOOD	1.7	GOOD	0.1
GOOD 10137.50		1.5	GOOD	1.6	GOOD	0.1	1.3	GOOD	1.4	GOOD	0.1
GOOD 10275.00		1.3	GOOD	1.4	GOOD	0.1	1.1	GOOD	1.2	GOOD	0.1
GOOD 10375.00		1.4	GOOD	1.6	GOOD	0.1	1.2	GOOD	1.4	GOOD	0.2
GOOD 10475.00		1.6	GOOD	1.7	GOOD	0.1	1.3	GOOD	1.6	GOOD	0.2
GOOD 10550.00		1.2	GOOD	1.3	GOOD	0.1	1.1	GOOD	1.2	GOOD	0.1
GOOD 10705.00		1.7	GOOD	1.6	BNE	-0.1	1.4	GOOD	1.7	GOOD	0.3
GOOD 10815.00		1.3	GOOD	1.3	GOOD	0.0	1.3	GOOD	1.3	GOOD	0.0
GOOD 10925.00		2.1	GOOD	2.1	BNE	0.0	2.1	GOOD	2.1	GOOD	0.0
GOOD 11130.00		1.5	GOOD	1.6	GOOD	0.1	1.4	GOOD	1.5	GOOD	0.1
GOOD 11335.00		1.0	GOOD	1.1	GOOD	0.1	0.9	GOOD	1.0	GOOD	0.1
GOOD 11480.00		1.0	GOOD	1.2	GOOD	0.1	0.9	GOOD	1.0	GOOD	0.1
GOOD 11625.00		1.2	GOOD	1.4	GOOD	0.1	1.2	GOOD	1.2	GOOD	0.0
GOOD 11785.00		1.0	GOOD	1.0	BNE	0.0	1.0	GOOD	1.0	BNE	0.0
GOOD 11945.00		1.1	GOOD	1.1	BNE	0.0	1.1	GOOD	1.1	BNE	0.0
GOOD 11982.50		1.0	BNE	1.0	BNE	0.0	1.0	BNE	1.1	BNE	0.0
GOOD 12020.00	Kruger Pde Bdg	0.9	BNE	0.9	BNE	0.0	0.9	BNE	0.9	BNE	0.0
GOOD 12032.00		4.4	BNE	4.4	BNE	0.0	4.4	BNE	4.4	BNE	0.0
GOOD 12044.00		2.2	BNE	2.2	BNE	0.0	2.2	BNE	2.2	BNE	0.0
GOOD 12093.50		0.9	GOOD	1.0	GOOD	0.0	0.9	GOOD	0.9	GOOD	0.0
GOOD 12155.00		0.7	GOOD	0.8	GOOD	0.1	0.7	GOOD	0.7	GOOD	0.0
GOOD 12291.00		1.1	GOOD	1.2	GOOD	0.1	1.0	GOOD	1.0	GOOD	0.1
GOOD 12425.00		1.5	GOOD	1.6	GOOD	0.1	1.3	GOOD	1.4	GOOD	0.1

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
GOOD 12552.50		1.2	GOOD	1.3	GOOD	0.1	1.0	GOOD	1.1	GOOD	0.1
GOOD 12680.00		0.9	GOOD	1.0	GOOD	0.1	0.8	GOOD	0.9	GOOD	0.1
GOOD 12807.50		0.7	GOOD	0.7	GOOD	0.1	0.6	GOOD	0.6	GOOD	0.1
GOOD 12936.00		0.6	GOOD	0.6	GOOD	0.0	0.5	GOOD	0.5	GOOD	0.0
GOOD 13105.00		0.7	GOOD	0.8	GOOD	0.0	0.6	GOOD	0.6	GOOD	0.1
GOOD 13276.00		0.8	GOOD	0.9	GOOD	0.0	0.7	GOOD	0.8	GOOD	0.1
GOOD 13375.00		0.8	GOOD	0.9	GOOD	0.1	0.7	GOOD	0.8	GOOD	0.1
GOOD 13476.00		0.9	GOOD	1.0	GOOD	0.1	0.7	GOOD	0.8	GOOD	0.1
GOOD 13576.00		1.1	GOOD	1.1	GOOD	0.1	0.9	GOOD	0.9	GOOD	0.1
GOOD 13676.00		1.3	GOOD	1.3	GOOD	0.0	1.1	GOOD	1.2	GOOD	0.1
GOOD 13916.00		1.2	GOOD	1.3	GOOD	0.1	1.2	GOOD	1.2	GOOD	0.0
GOOD 14155.00		2.1	GOOD	2.1	BNE	0.0	2.1	BNE	2.1	GOOD	0.0
GOOD 14175.00		0.9	GOOD	0.9	BNE	0.0	0.8	BNE	0.8	GOOD	0.0
GOOD 14185.00		0.5	GOOD	0.5	BNE	0.0	0.5	BNE	0.5	GOOD	0.0
GOOD 14235.00	Ipswich Rd Bdg	3.0	GOOD	3.3	GOOD	0.3	2.3	GOOD	2.6	GOOD	0.3
GOOD 14265.00		0.6	BNE	0.7	GOOD	0.0	0.6	BNE	0.6	GOOD	0.0
GOOD 14320.00		0.7	GOOD	0.7	GOOD	0.1	0.6	BNE	0.6	GOOD	0.0
GOOD 14375.00		0.8	GOOD	0.8	GOOD	0.0	0.7	GOOD	0.8	GOOD	0.1
GOOD 14465.00		0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
GOOD 14565.00		0.8	BNE	0.8	BNE	0.0	0.8	BNE	0.8	GOOD	0.0
GOOD 14565.00		0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
GOOD 14576.00		0.4	BNE	0.4	BNE	0.0	0.4	BNE	0.4	BNE	0.0
GOOD 14595.00	Bris-Ips Rail Bdg	4.2	GOOD	4.3	GOOD	0.1	3.6	GOOD	3.9	GOOD	0.3
GOOD 14616.00		1.0	BNE	1.0	BNE	0.0	1.0	BNE	1.0	BNE	0.0
GOOD 14625.00		1.2	BNE	1.2	BNE	0.0	1.2	BNE	1.2	BNE	0.0
GOOD 14635.00		1.8	BNE	1.8	BNE	0.0	1.8	BNE	1.8	BNE	0.0
GOOD 14685.00		1.1	GOOD	1.0	BNE	-0.1	1.1	BNE	1.0	BNE	0.0
GOOD 14735.00		1.1	GOOD	1.0	BNE	-0.2	0.9	BNE	0.9	BNE	0.0
GOOD 14815.00		0.6	BNE	0.7	BNE	0.0	0.7	BNE	0.7	BNE	0.0
GOOD 14895.00	Brisbane Tce Bdg	0.7	BNE	0.8	BNE	0.1	0.7	GOOD	0.8	BNE	0.1
GOOD 14900.00		0.7	GOOD	0.7	GOOD	0.0	0.6	GOOD	0.7	GOOD	0.0
GOOD 14905.00		0.6	GOOD	0.6	GOOD	0.0	0.6	GOOD	0.6	GOOD	0.0
GOOD 14913.00		4.9	GOOD	4.9	BNE	0.0	4.9	BNE	4.9	BNE	0.0
GOOD 14920.00		1.1	GOOD	1.1	GOOD	0.0	1.0	GOOD	1.1	GOOD	0.0
GOOD 14926.00		1.2	GOOD	1.3	GOOD	0.0	1.2	GOOD	1.2	GOOD	0.0
GOOD 14930.00		1.4	GOOD	1.6	GOOD	0.0	1.3	GOOD	1.4	GOOD	0.1
GOOD 14952.50		1.3	GOOD	1.3	GOOD	0.0	1.2	GOOD	1.2	GOOD	0.0
GOOD 14975.00		1.2	BNE	1.3	BNE	0.1	1.1	GOOD	1.3	BNE	0.2
GOOD 15162.50		1.2	GOOD	1.2	GOOD	0.0	1.0	GOOD	1.1	GOOD	0.1
GOOD 15350.00		1.1	GOOD	1.2	GOOD	0.1	1.0	GOOD	1.0	GOOD	0.0
GOOD 15597.50		1.2	GOOD	1.3	GOOD	0.0	1.1	GOOD	1.2	GOOD	0.0
GOOD 15845.00		1.6	GOOD	1.6	GOOD	0.0	1.4	GOOD	1.5	GOOD	0.1
GOOD 16010.00		1.7	GOOD	1.7	GOOD	0.0	1.5	GOOD	1.5	GOOD	0.1
GOOD 16175.00		1.9	GOOD	1.9	GOOD	0.1	1.6	GOOD	1.7	GOOD	0.1
GOOD 16265.00		2.1	GOOD	2.2	GOOD	0.1	1.8	GOOD	1.9	GOOD	0.1
GOOD 16355.00		2.4	GOOD	2.5	GOOD	0.1	2.0	GOOD	2.1	GOOD	0.1
GOOD 16440.00		2.7	GOOD	2.8	GOOD	0.1	2.3	GOOD	2.4	GOOD	0.1
GOOD 16525.00		3.1	GOOD	3.3	GOOD	0.1	2.6	GOOD	2.8	GOOD	0.2
GOOD 16626.00		4.7	GOOD	5.0	GOOD	0.3	3.5	GOOD	3.9	GOOD	0.4
GOOD 16725.00		9.4	GOOD	11.8	GOOD	2.4	5.6	GOOD	6.8	GOOD	1.1
SAND 10003.00		0.9	BNE	0.9	BNE	0.0	0.8	BNE	0.9	BNE	0.0
SAND 10160.00		0.9	SAND	0.9	SAND	0.0	0.9	SAND	0.9	SAND	0.1
SAND 10320.00		1.6	SAND	1.6	SAND	0.0	1.6	SAND	1.4	SAND	-0.1
SAND 10420.00		1.3	SAND	1.3	SAND	0.0	1.1	SAND	1.1	SAND	0.0
SAND 10620.00		1.0	SAND	1.0	SAND	0.0	0.9	SAND	0.9	SAND	0.0
SAND 10720.00		0.6	SAND	0.6	SAND	0.0	0.7	SAND	0.7	SAND	0.0
SAND 10820.00		0.9	BNE	0.9	BNE	0.0	0.9	BNE	0.9	BNE	0.0
SAND 10960.00		0.9	SAND	0.9	SAND	0.0	0.8	SAND	0.7	SAND	0.0
SAND 11040.00	Addison St Bdg	1.2	SAND	1.2	SAND	0.0	1.1	SAND	1.1	SAND	0.0
SAND 11051.00		2.9	BNE	2.9	BNE	0.0	2.9	BNE	2.9	BNE	0.0
SAND 11062.00		2.2	SAND	2.2	SAND	0.0	1.8	SAND	1.8	SAND	-0.1
SAND 11151.00		1.5	SAND	1.5	SAND	0.0	1.3	SAND	1.3	SAND	0.0
SAND 11240.00		1.3	SAND	1.3	SAND	0.1	1.1	SAND	1.0	BNE	0.0
SAND 11379.00		1.1	SAND	1.1	SAND	0.0	0.9	SAND	0.9	SAND	0.0
SAND 11518.00	Ishmael St Bdg	1.1	SAND	1.1	SAND	0.0	0.9	SAND	0.9	SAND	0.0
SAND 11529.00		2.7	BNE	2.7	BNE	0.0	2.7	BNE	2.7	BNE	0.0
SAND 11540.00		1.4	SAND	1.4	SAND	0.0	1.3	SAND	1.3	SAND	0.0
SAND 11650.00		1.0	SAND	1.0	SAND	0.0	1.0	SAND	1.0	SAND	0.0
SAND 11760.00		0.8	SAND	0.8	SAND	0.0	0.8	BNE	0.8	BNE	0.0
SAND 11879.00		1.1	SAND	1.1	SAND	0.0	1.1	SAND	1.1	SAND	0.0
SAND 11998.00	Cochrane St Bdg	1.5	BNE	1.6	BNE	0.0	1.5	BNE	1.5	BNE	0.0
SAND 12009.00		3.2	SAND	3.1	BNE	-0.1	3.1	SAND	3.0	SAND	-0.1
SAND 12020.00		2.1	SAND	1.9	SAND	-0.2	1.7	SAND	1.6	SAND	-0.1
SAND 12070.00		1.4	SAND	1.4	SAND	0.0	1.3	SAND	1.2	SAND	0.0
SAND 12120.00		1.1	SAND	1.1	SAND	0.0	1.0	SAND	0.9	SAND	0.0
SAND 12250.00		1.3	SAND	1.3	SAND	0.0	1.1	SAND	1.1	SAND	0.0
SAND 12440.00		1.8	BNE	1.8	SAND	-0.2	1.6	BNE	1.6	BNE	0.2
SAND 12565.00		1.6	SAND	1.6	SAND	0.0	1.5	SAND	1.5	SAND	0.0
SAND 12690.00		1.8	SAND	1.8	SAND	0.0	1.7	SAND	1.7	SAND	0.0
SAND 12855.00		2.1	SAND	2.1	SAND	0.0	2.0	SAND	1.8	SAND	-0.1
SAND 13020.00		2.6	SAND	2.6	SAND	-0.1	2.2	SAND	2.0	SAND	-0.1
SAND 13170.00		1.4	SAND	1.4	SAND	0.0	1.2	SAND	1.2	SAND	0.0
SAND 13320.00		1.0	SAND	1.0	SAND	0.0	0.9	SAND	0.8	SAND	0.0
SAND 13570.00		1.1	SAND	1.1	SAND	0.0	0.9	SAND	0.9	SAND	0.0
SAND 13820.00		1.3	SAND	1.2	SAND	0.0	1.1	SAND	1.0	SAND	0.0
SAND 14020.00		1.1	SAND	1.4	SAND	0.3	0.9	SAND	1.2	SAND	0.2
SAND 14220.00		2.0	SAND	2.6	SAND	0.6	1.4	SAND	2.0	SAND	0.7
SAND 14420.00		1.1	SAND	1.1	SAND	0.0	1.0	SAND	1.0	SAND	0.0
SAND 14620.00		6.9	BNE	2.4	BNE	-4.4	5.6	BNE	2.4	BNE	-3.2
SAND 14660.00		1.2	SAND	1.1	SAND	-0.1	1.0	SAND	0.9	SAND	-0.1

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
SAND 14700.00	Logan Motorway xing	0.9	SAND	0.9	SAND	-0.1	0.8	SAND	0.7	SAND	-0.1
SAND 14720.00		1.6	SAND	1.3	SAND	-0.3	1.0	SAND	0.7	SAND	-0.2
SAND 14740.00		1.0	SAND	0.9	SAND	-0.1	0.8	SAND	0.7	SAND	-0.1
SAND 14760.00		1.2	SAND	1.1	SAND	-0.1	1.0	SAND	0.8	SAND	-0.1
SAND 14820.00		2.7	SAND	3.1	BNE	0.4	2.3	SAND	2.7	SAND	0.3
SAND 15068.89		1.5	SAND	1.4	SAND	-0.1	1.3	SAND	1.2	SAND	-0.1
SAND 15317.78		1.6	SAND	2.0	SAND	0.4	1.3	SAND	1.6	SAND	0.3
SAND 15566.67		1.6	SAND	1.5	SAND	-0.1	1.4	SAND	1.3	SAND	-0.1
SAND 15815.56		1.6	SAND	1.5	SAND	-0.1	1.4	SAND	1.4	SAND	0.0
SAND 16064.45		1.6	SAND	1.6	SAND	-0.1	1.4	SAND	1.4	SAND	-0.1
SAND 16313.33		1.7	SAND	1.6	SAND	-0.1	1.5	SAND	1.4	SAND	-0.1
SAND 16562.22		1.7	SAND	1.6	SAND	-0.1	1.5	SAND	1.4	SAND	-0.1
SAND 16811.11		1.8	SAND	1.7	SAND	-0.1	1.6	SAND	1.4	SAND	-0.1
SAND 17060.00		1.8	SAND	1.7	SAND	-0.1	1.6	SAND	1.5	SAND	-0.1
SAND 17308.89		1.8	SAND	1.7	SAND	-0.1	1.6	SAND	1.5	SAND	-0.1
SAND 17557.78		1.9	SAND	1.8	SAND	-0.1	1.7	SAND	1.5	SAND	-0.1
SAND 17806.67		1.9	SAND	1.8	SAND	-0.1	1.7	SAND	1.6	SAND	-0.1
SAND 18055.56		1.9	SAND	1.8	SAND	-0.1	1.7	SAND	1.6	SAND	-0.2
SAND 18304.45		2.0	SAND	1.8	SAND	-0.1	1.8	SAND	1.6	SAND	-0.2
SAND 18553.34		2.1	SAND	2.0	SAND	-0.1	1.7	SAND	1.6	SAND	-0.1
SAND 18802.22		2.2	SAND	2.1	SAND	-0.1	1.7	BNE	1.7	BNE	-0.1
SAND 19051.11		3.1	SAND	2.9	SAND	-0.2	2.0	SAND	2.0	SAND	0.1
SAND 19300.00		5.3	SAND	4.7	SAND	-0.6	2.4	SAND	2.8	SAND	0.4
WOOG 10000.00		1.4	WOOG	1.4	WOOG	0.0	1.2	WOOG	1.3	BNE	0.1
WOOG 10225.00		1.3	WOOG	1.3	WOOG	0.0	1.1	WOOG	1.1	WOOG	0.0
WOOG 10450.00		1.2	WOOG	1.2	BNE	0.0	1.0	WOOG	1.0	WOOG	0.0
WOOG 10650.00		1.7	WOOG	1.7	WOOG	0.0	1.5	WOOG	1.5	WOOG	0.0
WOOG 10930.00		3.1	WOOG	3.0	WOOG	-0.1	2.7	WOOG	2.7	WOOG	0.0
WOOG 11040.00		2.2	WOOG	2.1	WOOG	-0.1	1.9	WOOG	1.9	WOOG	0.0
WOOG 11150.00		1.7	WOOG	1.9	WOOG	0.2	1.5	WOOG	1.8	WOOG	0.3
WOOG 11340.00		2.1	WOOG	2.1	WOOG	-0.1	1.8	WOOG	1.8	WOOG	0.0
WOOG 11530.00		2.8	WOOG	2.7	WOOG	-0.1	2.4	WOOG	2.3	WOOG	0.0
WOOG 11780.00		1.5	WOOG	1.7	WOOG	0.2	1.4	WOOG	1.6	WOOG	0.2
WOOG 12030.00		1.0	WOOG	1.1	WOOG	0.1	1.0	WOOG	1.1	WOOG	0.1
WOOG 12080.00		1.0	WOOG	1.2	WOOG	0.1	1.0	WOOG	1.1	WOOG	0.2
WOOG 12130.00		1.1	WOOG	1.3	WOOG	0.2	1.0	WOOG	1.2	WOOG	0.2
WOOG 12375.00		1.3	WOOG	1.2	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 12620.00		1.8	BNE	1.8	BNE	0.0	1.8	BNE	1.8	BNE	0.0
WOOG 12775.00		1.6	WOOG	1.6	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 12930.00		1.6	WOOG	1.6	WOOG	0.0	1.3	WOOG	1.3	WOOG	0.0
WOOG 13000.00		1.6	WOOG	1.6	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 13070.00		1.6	WOOG	1.6	WOOG	0.0	1.5	WOOG	1.5	WOOG	0.0
WOOG 13160.00		1.3	WOOG	1.4	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 13250.00		1.1	WOOG	1.2	WOOG	0.0	1.0	WOOG	1.1	WOOG	0.0
WOOG 13380.00		1.1	WOOG	1.1	WOOG	0.0	1.0	WOOG	1.0	WOOG	0.0
WOOG 13510.00		1.3	WOOG	1.2	WOOG	-0.1	1.2	BNE	1.2	BNE	0.0
WOOG 13530.00		1.3	WOOG	1.3	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 13550.00		1.5	WOOG	1.6	WOOG	0.0	1.3	BNE	1.4	WOOG	0.1
WOOG 13595.00		1.5	WOOG	1.6	WOOG	0.1	1.5	BNE	1.6	WOOG	0.1
WOOG 13640.00		1.8	WOOG	1.9	WOOG	0.1	1.7	WOOG	1.9	WOOG	0.2
WOOG 13705.00		1.5	WOOG	1.5	WOOG	0.0	1.4	BNE	1.6	BNE	0.1
WOOG 13770.00		1.2	WOOG	1.2	WOOG	0.0	1.1	WOOG	1.3	WOOG	0.2
WOOG 13785.00		1.1	WOOG	1.3	WOOG	0.2	1.0	BNE	1.1	WOOG	0.2
WOOG 13800.00		1.0	WOOG	1.3	WOOG	0.3	0.9	WOOG	1.0	WOOG	0.1
WOOG 13900.00		1.3	WOOG	1.3	WOOG	0.0	1.1	WOOG	1.1	WOOG	0.0
WOOG 14000.00		1.6	WOOG	1.6	WOOG	0.0	1.6	WOOG	1.5	WOOG	0.0
WOOG 14035.00		2.2	WOOG	2.1	WOOG	0.0	2.1	BNE	2.0	BNE	0.0
WOOG 14070.00		3.2	WOOG	3.5	WOOG	0.2	4.9	BNE	4.7	BNE	-0.3
WOOG 14085.00		3.4	WOOG	3.3	WOOG	-0.1	2.7	WOOG	2.7	BNE	0.0
WOOG 14100.00		4.6	WOOG	4.5	WOOG	-0.1	3.4	WOOG	3.3	WOOG	-0.1
WOOG 14140.00		3.8	WOOG	3.7	WOOG	-0.1	3.0	WOOG	3.0	WOOG	-0.1
WOOG 14180.00		3.2	WOOG	3.2	WOOG	-0.1	2.7	WOOG	2.7	WOOG	0.0
WOOG 14316.00		2.4	WOOG	2.4	WOOG	0.0	2.3	WOOG	2.3	WOOG	0.0
WOOG 14450.00		2.1	WOOG	2.2	WOOG	0.1	2.1	WOOG	2.1	WOOG	0.0
WOOG 14620.00		2.1	BNE	2.2	WOOG	0.1	2.1	BNE	2.1	WOOG	0.0
WOOG 14780.00		2.1	BNE	2.1	WOOG	0.0	2.1	BNE	2.1	WOOG	0.0
WOOG 14820.00		2.7	WOOG	2.6	WOOG	-0.1	2.4	BNE	2.4	BNE	0.0
WOOG 14850.00		4.4	WOOG	4.3	WOOG	-0.1	3.7	WOOG	3.6	WOOG	-0.1
WOOG 14880.00		2.2	WOOG	2.1	WOOG	0.0	1.9	WOOG	1.9	WOOG	0.0
WOOG 14910.00		1.4	WOOG	1.4	WOOG	0.0	1.4	BNE	1.4	BNE	0.0
WOOG 14920.00		1.3	WOOG	1.2	WOOG	0.0	1.1	WOOG	1.1	WOOG	0.0
WOOG 14930.00		1.1	WOOG	1.1	WOOG	0.0	0.9	WOOG	0.8	WOOG	0.0
WOOG 14940.00		1.4	WOOG	1.3	WOOG	0.0	1.2	WOOG	1.1	WOOG	0.0
WOOG 14950.00		1.7	WOOG	1.6	WOOG	0.0	1.6	BNE	1.6	WOOG	0.0
WOOG 14980.00		1.4	WOOG	1.4	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 15010.00		1.3	WOOG	1.2	WOOG	0.0	1.0	WOOG	1.0	WOOG	0.0
WOOG 15017.50		1.4	WOOG	1.4	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 15025.00		1.7	WOOG	1.6	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 15037.50		2.2	WOOG	2.2	WOOG	0.0	1.9	WOOG	1.8	WOOG	0.0
WOOG 15050.00		3.4	WOOG	3.4	WOOG	-0.1	2.9	WOOG	2.8	WOOG	-0.1
WOOG 15085.00		2.8	WOOG	2.6	WOOG	0.0	2.2	WOOG	2.2	WOOG	0.0
WOOG 15120.00		2.1	WOOG	2.1	WOOG	0.0	1.9	WOOG	2.0	BNE	0.1
WOOG 15135.00		2.1	WOOG	2.1	WOOG	0.0	2.0	BNE	2.0	BNE	0.0
WOOG 15160.00		2.7	WOOG	2.8	BNE	0.1	2.7	BNE	2.7	BNE	0.1
WOOG 15190.00		2.2	WOOG	2.1	WOOG	0.0	1.9	WOOG	1.9	WOOG	0.0
WOOG 15230.00		2.9	WOOG	2.9	WOOG	0.0	2.6	WOOG	2.5	WOOG	-0.1
WOOG 15265.00		2.7	WOOG	2.7	WOOG	0.0	2.5	WOOG	2.5	WOOG	0.0
WOOG 15300.00		6.1	BNE	5.0	WOOG	-1.1	5.9	BNE	5.0	BNE	-0.9
WOOG 15335.00		1.9	WOOG	1.9	BNE	0.0	1.6	WOOG	1.8	BNE	0.2
WOOG 15370.00		1.5	WOOG	1.6	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

MIKE11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
WOOG 15420.00		1.8	WOOG	1.8	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 15470.00		2.2	WOOG	2.2	WOOG	0.0	1.8	WOOG	1.7	WOOG	-0.1
WOOG 15405.00		2.0	WOOG	2.0	WOOG	0.0	1.8	WOOG	1.8	WOOG	0.0
WOOG 15520.00		2.5	WOOG	2.6	WOOG	0.2	2.4	BNE	2.5	WOOG	0.0
WOOG 15560.00		2.8	WOOG	2.8	WOOG	0.2	2.6	BNE	2.7	WOOG	0.0
WOOG 15600.00		3.7	WOOG	3.7	WOOG	0.0	3.3	WOOG	3.2	WOOG	-0.1
WOOG 15660.00		1.5	BNE	1.6	BNE	0.1	1.8	WOOG	1.8	WOOG	0.1
WOOG 15720.00		1.2	WOOG	1.2	WOOG	0.0	1.2	BNE	1.2	BNE	0.0
WOOG 15760.00		1.8	BNE	1.7	BNE	0.0	1.7	WOOG	1.7	WOOG	0.0
WOOG 15800.00		3.8	BNE	3.7	WOOG	0.1	3.5	WOOG	3.6	WOOG	0.0
WOOG 15820.00		2.8	WOOG	2.9	WOOG	0.0	2.8	WOOG	2.9	BNE	0.1
WOOG 15840.00	Edna St Bdg	2.5	WOOG	2.5	WOOG	0.0	2.5	WOOG	2.6	BNE	0.1
WOOG 15850.00		3.1	WOOG	3.3	WOOG	0.1	3.1	WOOG	3.2	BNE	0.0
WOOG 15860.00		2.3	BNE	2.4	BNE	0.1	2.2	BNE	2.3	BNE	0.0
WOOG 15910.00		1.8	WOOG	1.8	WOOG	0.1	1.8	WOOG	1.8	WOOG	0.1
WOOG 15960.00		2.8	WOOG	2.8	BNE	0.0	2.7	WOOG	2.8	WOOG	0.1
WOOG 15975.00		2.3	WOOG	2.3	BNE	0.0	2.2	WOOG	2.3	WOOG	0.1
WOOG 15990.00		2.0	WOOG	2.0	WOOG	0.1	1.9	WOOG	1.9	WOOG	0.0
WOOG 16000.00		1.2	WOOG	1.2	BNE	0.0	1.1	WOOG	1.2	BNE	0.1
WOOG 16010.00		1.5	BNE	1.6	BNE	0.1	1.6	BNE	1.5	BNE	0.0
WOOG 16067.50		1.5	WOOG	1.6	BNE	0.0	1.5	WOOG	1.6	BNE	0.0
WOOG 16125.00		3.1	WOOG	3.1	BNE	-0.1	3.1	WOOG	3.0	BNE	-0.1
WOOG 16137.50		2.1	WOOG	2.1	WOOG	0.0	2.0	WOOG	2.0	WOOG	0.0
WOOG 16150.00		2.0	WOOG	1.9	WOOG	0.0	1.6	WOOG	1.6	WOOG	0.0
WOOG 16212.50		2.7	WOOG	2.7	WOOG	-0.1	2.2	WOOG	2.2	WOOG	0.0
WOOG 16275.00		4.5	WOOG	4.4	WOOG	-0.1	3.6	WOOG	3.4	WOOG	-0.1
WOOG 16357.50		2.3	WOOG	2.4	WOOG	0.1	2.3	WOOG	2.3	WOOG	0.1
WOOG 16440.00		1.9	WOOG	2.0	WOOG	0.1	1.8	WOOG	1.9	WOOG	0.0
WOOG 16520.00		1.8	WOOG	1.8	WOOG	0.1	1.7	WOOG	1.7	WOOG	0.0
WOOG 16600.00		2.0	WOOG	2.0	WOOG	0.0	1.8	WOOG	1.8	WOOG	0.0
WOOG 16650.00		1.5	WOOG	1.6	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 16700.00		1.4	BNE	1.4	BNE	0.1	1.4	WOOG	1.4	WOOG	0.0
WOOG 16775.00		1.6	BNE	1.6	BNE	0.1	1.6	WOOG	1.7	BNE	0.0
WOOG 16850.00		2.6	WOOG	2.5	WOOG	0.0	2.5	WOOG	2.6	WOOG	0.0
WOOG 16875.00		2.6	WOOG	2.6	WOOG	0.0	2.6	WOOG	2.6	WOOG	0.0
WOOG 16900.00		2.7	WOOG	2.8	WOOG	0.1	2.8	WOOG	2.8	WOOG	0.0
WOOG 16975.00		2.6	WOOG	2.7	WOOG	0.1	2.7	WOOG	2.7	WOOG	0.1
WOOG 17050.00		3.1	WOOG	3.1	WOOG	0.0	2.8	WOOG	2.6	WOOG	0.0
WOOG 17087.50		1.5	WOOG	1.6	BNE	0.1	1.6	WOOG	1.7	BNE	0.1
WOOG 17125.00		1.3	BNE	1.4	BNE	0.1	1.4	WOOG	1.5	BNE	0.1
WOOG 17200.00		1.3	WOOG	1.3	BNE	0.0	1.4	WOOG	1.6	BNE	0.1
WOOG 17275.00		2.2	WOOG	2.2	WOOG	0.0	2.1	WOOG	2.1	WOOG	0.0
WOOG 17292.50		1.3	WOOG	1.3	WOOG	0.0	1.3	WOOG	1.3	WOOG	0.0
WOOG 17310.00		1.1	WOOG	1.1	BNE	0.0	1.1	WOOG	1.2	WOOG	0.0
WOOG 17340.00	Ipswich Rd Bdg	3.7	WOOG	3.6	WOOG	0.0	3.6	BNE	3.6	WOOG	0.0
WOOG 17370.00		3.2	WOOG	3.2	WOOG	0.0	2.8	WOOG	2.8	WOOG	-0.1
WOOG 17405.00		2.9	WOOG	2.9	WOOG	0.0	2.5	WOOG	2.6	WOOG	0.1
WOOG 17440.00	Bris-Ipswich Rail Bdg	3.2	WOOG	3.1	WOOG	-0.1	2.6	WOOG	2.8	BNE	0.2
WOOG 17450.00		3.6	BNE	2.9	WOOG	-0.7	3.0	WOOG	4.6	WOOG	1.6
WOOG 17460.00		1.7	WOOG	1.7	BNE	0.0	1.5	WOOG	1.5	BNE	0.0
WOOG 17480.00		1.6	WOOG	1.6	WOOG	0.0	1.5	WOOG	1.5	WOOG	0.0
WOOG 17500.00		2.1	WOOG	2.1	WOOG	0.0	1.8	WOOG	1.8	WOOG	-0.1
WOOG 17525.00		2.0	WOOG	2.0	WOOG	0.0	1.9	WOOG	1.8	WOOG	-0.1
WOOG 17550.00		2.1	WOOG	2.1	WOOG	0.0	1.9	WOOG	1.9	WOOG	-0.1
WOOG 17565.00		2.0	WOOG	2.0	WOOG	0.0	1.9	WOOG	1.8	WOOG	0.0
WOOG 17580.00		3.5	BNE	6.3	BNE	1.9	9.9	BNE	13.7	BNE	3.8
WOOG 17590.00		2.1	WOOG	2.0	WOOG	0.0	1.8	WOOG	1.7	WOOG	0.0
WOOG 17600.00		2.2	WOOG	2.2	WOOG	0.0	1.7	WOOG	1.7	WOOG	0.0
WOOG 17607.50		1.8	WOOG	1.9	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 17615.00		1.7	WOOG	1.6	WOOG	0.0	1.2	WOOG	1.2	WOOG	0.0
WOOG 17682.50		1.7	WOOG	1.7	WOOG	0.0	1.4	WOOG	1.4	WOOG	0.0
WOOG 17750.00	Brisbane Tce Bdg	1.9	WOOG	1.9	WOOG	0.0	1.7	WOOG	1.7	WOOG	0.0
WOOG 17755.00		1.9	WOOG	1.9	WOOG	0.0	1.8	WOOG	1.8	WOOG	0.0
WOOG 17760.00		2.1	WOOG	2.1	WOOG	0.1	2.1	WOOG	2.1	WOOG	0.0
WOOG 17770.00		1.6	WOOG	1.6	WOOG	0.1	1.6	WOOG	1.6	WOOG	0.0
WOOG 17780.00		2.3	BNE	2.5	WOOG	0.1	2.3	BNE	2.3	BNE	0.0
WOOG 17865.00		2.1	WOOG	2.1	WOOG	0.1	2.0	WOOG	2.1	WOOG	0.0
WOOG 17950.00		2.0	WOOG	2.0	WOOG	0.1	1.9	WOOG	1.9	WOOG	0.0
WOOG 17955.00		1.9	WOOG	1.9	WOOG	0.0	1.9	WOOG	1.9	WOOG	0.0
WOOG 17960.00		1.8	WOOG	1.8	BNE	0.0	1.8	WOOG	1.8	WOOG	0.0
WOOG 18105.00		1.9	WOOG	1.9	WOOG	0.0	1.9	WOOG	1.9	WOOG	0.0
WOOG 18250.00		2.4	WOOG	2.4	WOOG	0.0	2.3	WOOG	2.3	WOOG	0.0
WOOG 18375.00		2.8	WOOG	2.8	WOOG	0.0	2.5	WOOG	2.5	WOOG	0.0
WOOG 18500.00		3.4	WOOG	3.3	WOOG	0.0	2.9	WOOG	2.8	WOOG	-0.1
WOOG 18625.00		3.3	WOOG	3.3	WOOG	0.0	2.7	WOOG	2.6	WOOG	-0.1
WOOG 18750.00		3.2	WOOG	3.2	WOOG	-0.1	2.5	WOOG	2.5	WOOG	-0.1
WOOG 18825.00		3.8	WOOG	3.8	WOOG	0.0	3.1	WOOG	3.0	WOOG	-0.1
WOOG 18900.00		4.7	WOOG	4.6	WOOG	0.0	4.0	WOOG	3.9	WOOG	0.0
WOOG 18987.50		7.0	WOOG	7.0	WOOG	0.0	5.6	WOOG	5.6	WOOG	0.1
WOOG 19075.00		14.4	WOOG	15.8	WOOG	1.5	9.3	WOOG	10.1	WOOG	0.7
WAR 100000.00	Cunningham Hway	3.1	BREM	3.2	BREM	0.1	2.7	BNE	2.6	BNE	0.0
WAR 100249.50		2.2	WAR	2.3	WAR	0.0	2.0	WAR	2.2	BNE	0.1
WAR 100499.00		1.7	BNE	2.2	BNE	0.5	1.6	BREM	2.2	BNE	0.6
WAR 100738.00		1.8	WAR	2.1	BNE	0.2	1.8	WAR	1.9	BNE	0.0
WAR 100973.00		2.0	BNE	1.9	BNE	0.0	1.9	BREM	1.9	BREM	0.0
WAR 101128.50		2.4	WAR	2.5	WAR	0.0	2.4	WAR	2.4	WAR	0.0
WAR 101284.00		3.2	BNE	3.3	BREM	0.1	3.0	BREM	3.1	BREM	0.1
WAR 101459.50		3.2	BNE	3.3	BREM	0.0	3.1	WAR	3.1	BREM	0.0
WAR 101605.00		3.3	BNE	3.5	BREM	0.2	3.2	BNE	3.2	BNE	0.0
WAR 101734.50		3.0	BREM	3.4	BREM	0.3	3.1	BNE	3.1	BNE	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
WAR 101874.00		2.9	BREM	3.2	BREM	0.3	3.0	BNE	3.1	BNE	0.0
WAR 102013.50		2.7	BREM	2.9	BREM	0.3	2.8	BREM	2.8	BNE	0.0
WAR 102153.00		2.6	BREM	2.7	BREM	0.2	2.8	BREM	2.7	BREM	-0.1
WAR 102306.50		2.4	BREM	2.7	BNE	0.2	2.7	BREM	2.7	BREM	-0.1
WAR 102460.00		2.6	BNE	2.9	BREM	0.4	2.8	BREM	2.7	BNE	0.0
WAR 102613.50		2.9	BNE	3.6	BREM	0.7	2.9	BREM	3.2	BNE	0.3
WAR 102767.00		3.2	BNE	3.8	BREM	0.6	3.3	BNE	3.4	BNE	0.1
WAR 102958.25		2.8	BNE	3.6	BREM	0.7	3.0	BNE	3.2	BNE	0.2
WAR 103149.50		2.6	BNE	3.2	BREM	0.7	2.8	BREM	2.8	BNE	0.2
WAR 103340.75		2.4	BNE	3.1	BREM	0.7	2.7	BREM	2.8	BREM	0.1
WAR 103532.00		2.2	BREM	3.1	BREM	0.8	2.7	BREM	3.0	BREM	0.2
WAR 103681.50		2.3	WAR	3.1	BREM	0.8	2.7	BREM	2.9	BREM	0.3
WAR 103831.00		2.5	WAR	3.2	WAR	0.7	2.8	WAR	3.1	WAR	0.2
WAR 103980.00		2.8	BREM	3.6	WAR	0.8	2.8	WAR	3.3	BNE	0.6
WAR 104129.00		3.7	BREM	4.2	BNE	0.6	3.5	BREM	4.1	BNE	0.6
WAR 104208.00		3.6	BREM	4.3	BNE	0.7	3.6	BREM	4.3	BNE	0.7
WAR 104287.00		3.6	BREM	4.4	BNE	0.9	3.7	BREM	4.4	BNE	0.7
WAR 104365.50		3.1	BREM	4.0	WAR	1.5	3.4	BREM	4.4	BNE	1.0
WAR 104444.00		3.0	WAR	4.9	BREM	1.9	3.4	WAR	4.7	BNE	1.3
WAR 104624.50		2.6	WAR	4.5	WAR	1.9	2.9	WAR	4.1	BNE	1.2
WAR 104805.00		2.3	WAR	4.2	WAR	2.0	2.6	WAR	3.6	BNE	1.1
WAR 104985.50		2.0	WAR	3.6	WAR	1.6	2.3	WAR	2.9	BNE	0.7
WAR 105166.00		1.8	WAR	3.1	WAR	1.3	2.0	WAR	2.4	BNE	0.3
WAR 105309.50		3.1	WAR	3.4	WAR	0.3	2.7	WAR	3.0	BNE	0.3
WAR 105453.00		3.5	BREM	3.7	WAR	0.2	3.2	BNE	3.6	BNE	0.3
WAR 105629.50		2.7	BREM	3.0	WAR	0.3	2.6	WAR	2.8	WAR	0.2
WAR 105806.00		2.8	WAR	3.2	WAR	0.4	2.8	WAR	3.0	WAR	0.2
WAR 105054.50		2.5	WAR	2.6	WAR	0.3	2.4	WAR	2.6	WAR	0.2
WAR 105303.00		2.4	WAR	2.5	WAR	0.1	2.2	BNE	2.3	WAR	0.1
WAR 105433.50		2.9	WAR	2.9	WAR	0.0	2.8	BNE	2.7	WAR	-0.1
WAR 105564.00		3.9	WAR	3.9	WAR	0.0	3.6	BNE	3.5	WAR	-0.1
WAR 105739.00		3.7	WAR	3.8	WAR	0.1	3.3	BNE	3.3	WAR	0.0
WAR 106914.00		3.7	WAR	3.8	WAR	0.1	3.2	WAR	3.2	WAR	0.1
WAR 107068.00		3.5	WAR	3.6	WAR	0.1	2.7	WAR	2.8	WAR	0.1
WAR 107222.00		3.3	WAR	3.6	WAR	0.2	2.6	WAR	2.7	WAR	0.0
WAR 107376.00		3.6	WAR	3.9	WAR	0.2	3.0	WAR	3.0	WAR	0.0
WAR 107530.00		4.1	WAR	4.2	WAR	0.2	3.6	WAR	3.6	WAR	0.0
WAR 107682.50		4.6	WAR	4.9	WAR	0.3	3.7	WAR	3.6	WAR	-0.2
WAR 107835.00		5.5	WAR	6.0	WAR	0.5	3.9	WAR	3.6	WAR	-0.4
WAR 107987.50		10.1	WAR	10.7	WAR	0.6	6.9	WAR	6.3	WAR	-0.6
WAR 108140.00		194.2	WAR	83.8	WAR	-110.4	44.1	WAR	41.1	WAR	-3.0
PURGA 100000.00		1.6	BNE	1.5	BNE	0.0	1.6	BNE	1.5	BNE	0.0
PURGA 100216.00		1.5	PURGA	1.5	PURGA	0.0	1.2	PURGA	1.2	PURGA	0.0
PURGA 100432.00		1.8	BNE	1.8	BNE	0.0	1.7	BNE	1.7	BNE	0.0
PURGA 100602.50		1.4	PURGA	1.5	PURGA	0.0	1.2	PURGA	1.2	PURGA	0.0
PURGA 100773.00		2.4	BNE	2.3	BNE	-0.1	2.3	BNE	2.4	BNE	0.2
PURGA 100943.00		1.4	PURGA	1.4	PURGA	0.0	1.2	PURGA	1.2	PURGA	0.0
PURGA 101113.00		1.9	BREM	1.6	BNE	-0.3	1.6	BNE	1.4	BNE	-0.2
PURGA 101296.00		1.4	BREM	1.4	PURGA	0.0	1.2	BNE	1.2	PURGA	0.0
PURGA 101479.00		1.5	WAR	1.3	PURGA	-0.2	1.2	BNE	1.2	BNE	0.0
PURGA 101662.00		1.4	PURGA	1.4	PURGA	0.0	1.2	PURGA	1.2	PURGA	0.0
PURGA 101845.00		1.6	BREM	1.4	PURGA	-0.1	1.3	BNE	1.3	BNE	0.0
PURGA 102009.50		1.7	PURGA	1.7	PURGA	0.0	1.7	PURGA	1.7	PURGA	0.0
PURGA 102174.00		2.4	PURGA	2.4	PURGA	0.0	2.4	PURGA	2.4	PURGA	0.0
PURGA 102338.00		4.2	PURGA	4.2	PURGA	0.0	4.0	PURGA	4.0	PURGA	0.0
PURGA 102502.00		32.7	PURGA	33.1	PURGA	0.4	28.0	PURGA	27.8	PURGA	-0.2
PWLINK1 0.00		326.9	BNE	334.0	BNE	7.2	0.0	PURGA	0.0	BNE	0.0
PWLINK1 0.50		2.4	BNE	2.4	BNE	0.0	0.4	PURGA	0.4	BNE	0.0
PWLINK1 1.00		326.9	BNE	334.0	BNE	7.2	0.0	PURGA	0.0	BNE	0.0
PWLINK3 0.00		203.7	BREM	196.6	BREM	-7.1	27.7	BNE	20.7	BNE	-7.0
PWLINK3 0.50		2.1	BREM	2.0	BREM	0.0	1.1	BNE	1.0	BNE	-0.1
PWLINK3 1.00		203.7	BREM	196.6	BREM	-7.1	27.7	BNE	20.7	BNE	-7.0
PWLINK2 0.00		128.8	WAR	86.0	WAR	-42.8	13.3	BNE	7.6	BNE	-5.7
PWLINK2 0.50		1.3	WAR	1.2	WAR	-0.2	0.8	BNE	0.7	BNE	-0.1
PWLINK2 1.00		128.8	WAR	86.0	WAR	-42.8	13.3	BNE	7.6	BNE	-5.7
BREMBRISLINK1 0.00		61.5	BNE	60.9	BNE	-0.6	0.0	0.0	0.0	BNE	0.0
BREMBRISLINK1 75.00		2.6	BNE	2.6	BNE	0.0	0.0	0.0	0.0	0.0	0.0
BREMBRISLINK1 150.00		61.5	BNE	60.9	BNE	-0.6	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH1 0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH1 5.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH1 10.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH2 0.00		35.0	BNE	31.4	BNE	-3.6	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH2 25.00		1.6	BNE	1.6	BNE	0.0	0.0	0.0	0.0	0.0	0.0
BREMLINKBRANCH2 50.00		35.0	BNE	31.4	BNE	-3.6	0.0	0.0	0.0	0.0	0.0
BUND 10000.00		1.2	BUND	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
BUND 10153.75		1.4	BUND	1.4	BUND	0.0	1.3	BUND	1.3	BUND	0.0
BUND 10307.50		1.7	BUND	1.6	BUND	-0.1	1.5	BUND	1.5	BUND	0.0
BUND 10461.25		1.5	BUND	1.3	BUND	-0.1	1.3	BUND	1.3	BUND	0.0
BUND 10615.00		1.5	BUND	1.5	BREM	-0.1	1.2	BUND	1.5	BUND	0.2
BUND 10861.25		1.2	BUND	1.2	BUND	0.0	1.1	BUND	1.1	BUND	0.0
BUND 11107.50		1.3	BUND	1.3	BUND	0.0	1.2	BUND	1.4	BUND	0.2
BUND 11353.75		1.3	BUND	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
BUND 11600.00		1.6	BUND	1.5	BUND	-0.1	1.4	BUND	1.4	BUND	0.0
BUND 11784.17		2.0	BUND	1.8	BUND	0.2	1.6	BUND	1.6	BUND	0.0
BUND 11968.33		2.2	BUND	1.8	BUND	-0.4	1.6	BUND	1.6	BUND	0.0
BUND 12152.50		1.6	BUND	1.6	BUND	0.0	1.5	BUND	1.5	BUND	0.0
BUND 12336.67		1.5	BUND	1.5	BUND	0.0	1.5	BUND	1.5	BUND	0.0
BUND 12520.83		1.4	BUND	1.4	BUND	0.0	1.4	BUND	1.4	BUND	0.0
BUND 12705.00		1.6	BUND	1.4	BUND	-0.2	1.3	BUND	1.3	BUND	0.0
BUND 12935.00		1.8	BUND	1.7	BUND	-0.1	1.6	BUND	1.6	BUND	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

MIKE11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BUND 13165.00		2.2	BUND	2.2	BUND	0.0	2.2	BUND	2.2	BUND	0.0
BUND 13358.75		2.3	BUND	2.3	BUND	0.0	2.2	BUND	2.2	BUND	0.0
BUND 13552.50		2.3	BUND	2.3	BUND	0.0	2.3	BUND	2.3	BUND	0.0
BUND 13746.25		2.1	BUND	2.1	BUND	0.0	2.0	BUND	2.0	BUND	0.0
BUND 13940.00		2.1	BUND	1.9	BUND	-0.2	1.8	BUND	1.8	BUND	0.0
BUND 14078.75		1.8	BUND	1.8	BUND	0.0	1.7	BUND	1.7	BUND	0.0
BUND 14217.50		1.7	BUND	1.7	BUND	0.0	1.7	BUND	1.7	BUND	0.0
BUND 14356.25		2.2	BUND	2.2	BUND	0.0	2.1	BUND	2.1	BUND	0.0
BUND 14495.00		3.2	BUND	3.0	BUND	-0.2	2.9	BUND	2.9	BUND	0.0
BUND 14635.00		1.4	BUND	1.3	BUND	-0.1	1.2	BUND	1.3	BUND	0.0
BUND 14775.00		1.1	BUND	1.0	BREM	-0.1	1.0	BUND	0.9	BNE	-0.1
BUND 14915.00		0.9	BNE	0.8	BREM	-0.1	0.9	BNE	0.8	BNE	-0.1
BUND 15055.00		1.2	BUND	1.2	BUND	0.0	1.1	BUND	1.1	BNE	0.0
BUND 15216.25		0.8	BNE	0.7	BNE	0.0	0.7	BREM	0.7	BREM	0.0
BUND 15377.50		0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
BUND 15538.75		0.6	BNE	0.7	BNE	0.0	0.6	BNE	0.7	BNE	0.0
BUND 15700.00		1.0	BNE	1.1	BNE	0.1	1.0	BREM	1.1	BNE	0.1
BUND 15873.75		1.3	BUND	1.4	BREM	0.0	1.3	BUND	1.3	BUND	0.0
BUND 16047.50		1.6	BUND	1.5	BUND	0.0	1.4	BUND	1.4	BUND	0.0
BUND 16221.25		1.5	BUND	1.3	BUND	-0.1	1.3	BUND	1.3	BUND	0.0
BUND 16395.00		1.5	BUND	1.3	BUND	-0.2	1.2	BUND	1.2	BUND	0.0
BUND 16521.25		1.6	BUND	1.3	BUND	-0.2	1.3	BUND	1.2	BUND	0.0
BUND 16647.50		1.6	BUND	1.4	BUND	-0.2	1.3	BUND	1.2	BUND	-0.1
BUND 16773.75		1.6	BUND	1.5	BUND	-0.1	1.4	BUND	1.4	BUND	-0.1
BUND 16900.00		1.7	BUND	1.6	BUND	0.0	1.6	BUND	1.6	BUND	-0.1
BUND 17057.50		1.5	BUND	1.5	BUND	0.0	1.5	BUND	1.6	BUND	0.0
BUND 17215.00		1.5	BUND	1.5	BUND	0.0	1.5	BUND	1.5	BUND	0.0
BUND 17372.50		1.6	BUND	1.6	BUND	0.0	1.6	BUND	1.6	BUND	0.0
BUND 17530.00		2.0	BUND	2.0	BUND	0.0	1.9	BUND	1.8	BUND	-0.1
BUND 17707.50		1.8	BUND	1.7	BUND	0.0	1.7	BUND	1.7	BUND	0.0
BUND 17885.00		1.6	BNE	1.6	BNE	0.0	1.6	BUND	1.6	BUND	0.0
BUND 18096.25		1.3	BUND	1.3	BUND	0.0	1.3	BUND	1.2	BUND	0.0
BUND 18307.50		1.3	BNE	1.3	BUND	0.0	1.3	BUND	1.2	BNE	0.0
BUND 18518.75		1.4	BNE	1.4	BUND	0.0	1.4	BUND	1.4	BNE	0.0
BUND 18730.00	Ripley Rd Bdg	1.6	BNE	1.6	BUND	0.1	1.6	BNE	1.5	BNE	0.0
BUND 18740.00		2.4	BREM	2.6	BUND	0.2	2.6	BNE	2.8	BREM	0.2
BUND 18750.00		1.9	BNE	1.9	BNE	0.0	2.0	BREM	1.9	BREM	-0.1
BUND 18882.50		1.8	BUND	1.8	BREM	0.0	1.8	BREM	1.7	BUND	0.0
BUND 19015.00		1.8	BUND	1.7	BNE	0.0	1.7	BREM	1.7	BNE	0.0
BUND 19147.50		1.8	BNE	1.8	BUND	0.0	1.8	BNE	1.8	BNE	0.0
BUND 19280.00		2.5	BNE	2.5	BUND	0.0	2.5	BUND	2.4	BUND	-0.1
BUND 19410.00		1.7	BUND	1.7	BUND	0.0	1.7	BUND	1.6	BUND	0.0
BUND 19540.00		1.3	BUND	1.3	BUND	0.0	1.3	BUND	1.3	BUND	0.0
BUND 19670.00		1.2	BUND	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
BUND 19800.00		1.1	BUND	1.1	BUND	0.0	1.1	BUND	1.1	BUND	0.0
BUND 19960.00		1.1	BUND	1.0	BUND	0.0	1.0	BUND	1.0	BUND	0.0
BUND 20120.00		1.0	BUND	1.0	BNE	0.0	1.0	BUND	1.0	BUND	0.0
BUND 20280.00		0.8	BUND	0.9	BNE	0.0	0.8	BUND	0.9	BREM	0.0
BUND 20440.00		0.8	BREM	0.9	BUND	0.0	0.8	BNE	0.9	BNE	0.0
BUND 20672.50		0.9	BREM	1.1	BREM	0.2	0.9	BREM	1.0	BUND	0.1
BUND 20905.00		0.9	BREM	1.1	BNE	0.1	0.9	BNE	1.0	BUND	0.0
BUND 21137.50		1.1	BNE	1.2	BREM	0.0	1.1	BUND	1.2	BUND	0.0
BUND 21370.00		1.6	BUND	1.6	BNE	0.0	1.6	BUND	1.6	BUND	0.0
BUND 21548.75		1.2	BUND	1.3	BUND	0.1	1.2	BUND	1.3	BUND	0.1
BUND 21727.50		1.0	BUND	1.3	BREM	0.2	1.0	BUND	1.3	BUND	0.3
BUND 21908.25		1.4	BUND	1.6	BREM	0.6	1.2	BUND	1.9	BUND	0.7
BUND 22085.00		4.0	BUND	8.7	BUND	4.7	2.6	BUND	8.3	BUND	5.9
BUND 22102.50		0.9	BUND	0.8	BUND	0.0	0.9	BNE	0.9	BUND	0.1
BUND 22120.00		0.9	BUND	0.9	BREM	0.0	0.9	BUND	0.9	BUND	0.1
BUND 22286.25		0.9	BUND	0.9	BUND	0.0	0.8	BUND	0.9	BUND	0.0
BUND 22452.50		1.0	BUND	1.0	BUND	0.0	0.9	BUND	1.0	BUND	0.1
BUND 22618.75		0.9	BUND	0.9	BREM	0.0	0.8	BUND	1.0	BUND	0.1
BUND 22785.00		0.9	BUND	0.9	BNE	0.0	0.9	BUND	0.9	BUND	0.0
BUND 22957.50		0.9	BUND	0.9	BUND	0.0	0.8	BUND	0.8	BUND	0.1
BUND 23150.00		0.8	BUND	0.9	BUND	0.0	0.7	BUND	0.8	BUND	0.1
BUND 23332.50		0.8	BUND	0.9	BUND	0.0	0.7	BUND	0.8	BUND	0.1
BUND 23515.00		0.8	BUND	0.9	BUND	0.0	0.7	BUND	0.8	BUND	0.1
BUND 23668.75		0.8	BUND	0.8	BREM	0.0	0.8	BUND	0.9	BUND	0.1
BUND 23822.50		1.1	BUND	1.0	BUND	0.0	1.0	BUND	0.9	BUND	0.0
BUND 23976.25		1.4	BUND	1.3	BUND	-0.1	1.2	BUND	1.2	BUND	-0.1
BUND 24130.00		1.9	BUND	1.8	BUND	-0.1	1.6	BUND	1.6	BUND	-0.1
BUND 24287.50		1.9	BUND	1.8	BUND	-0.1	1.6	BUND	1.6	BUND	-0.1
BUND 24445.00		1.9	BUND	1.8	BUND	-0.1	1.7	BUND	1.6	BUND	-0.1
BUND 24602.50		1.8	BUND	1.7	BUND	-0.1	1.5	BUND	1.6	BUND	-0.1
BUND 24760.00		1.8	BUND	1.6	BUND	-0.2	1.4	BUND	1.4	BUND	-0.1
BUND 24917.50		1.3	BUND	1.2	BUND	-0.1	1.1	BUND	1.0	BUND	-0.1
BUND 25075.00		1.1	BUND	1.1	BNE	0.1	0.9	BUND	1.1	BNE	0.2
BUND 25201.25		0.9	BUND	0.9	BUND	-0.1	0.8	BUND	0.8	BUND	0.0
BUND 25327.50		0.8	BUND	1.0	BNE	0.1	0.7	BUND	0.6	BUND	0.2
BUND 25453.75		0.8	BUND	0.8	BUND	0.0	0.8	BNE	0.8	BUND	0.0
BUND 25560.00	Swanbank Rd Bdg	1.1	BNE	1.1	BREM	0.0	1.1	BNE	1.1	BNE	0.0
BUND 25590.00		1.9	BNE	1.9	BNE	0.0	1.9	BUND	1.9	BNE	0.0
BUND 25600.00		1.2	BREM	1.2	BREM	0.0	1.2	BNE	1.2	BNE	0.0
BUND 25835.00		0.6	BUND	0.7	BUND	-0.1	0.7	BNE	0.8	BREM	0.0
BUND 26070.00		0.8	BUND	0.8	BUND	-0.1	0.7	BUND	0.7	BUND	0.0
BUND 26305.00		0.9	BUND	1.0	BNE	0.1	0.9	BNE	0.9	BUND	0.1
BUND 26540.00		1.6	BNE	1.7	BREM	0.1	1.6	BNE	1.7	BUND	0.0
BUND 26663.00		0.8	BUND	0.9	BUND	-0.1	0.8	BUND	0.8	BUND	0.0
BUND 26783.00		0.8	BUND	0.8	BUND	-0.1	0.7	BUND	0.7	BUND	-0.1
BUND 27030.00		0.8	BUND	0.8	BUND	0.0	0.7	BUND	0.8	BUND	0.1

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) (m/s)		100y ARI (Ultimate) (m/s)		Diff (m/s)	20y ARI (Existing) (m/s)		20y ARI (Ultimate) (m/s)		Diff (m/s)
BUND 27280.00		0.9	BUND	1.0	BREM	0.1	0.8	BUND	1.0	BUND	0.2
BUND 27330.00		0.9	BUND	1.0	BREM	0.1	0.7	BUND	0.9	BUND	0.2
BUND 27360.00	Perkins St Bdg	1.0	BUND	1.1	BREM	0.1	0.7	BUND	0.8	BUND	0.2
BUND 27390.00		1.9	BREM	1.8	BUND	-0.1	1.7	BUND	1.8	BUND	0.0
BUND 27400.00		1.0	BREM	1.0	BREM	0.0	0.9	BUND	1.0	BUND	0.1
BUND 27527.50		0.8	BUND	0.8	BUND	0.0	0.7	BUND	0.7	BUND	0.0
BUND 27655.00		0.9	BUND	0.9	BUND	0.0	0.8	BUND	0.8	BNE	0.0
BUND 27665.00		1.0	BUND	0.9	BUND	0.0	0.8	BUND	0.8	BNE	0.0
BUND 27675.00		2.4	BREM	2.4	BREM	-0.1	1.4	BNE	1.8	BUND	0.4
BUND 27842.50		1.1	BUND	1.1	BUND	0.1	1.0	BUND	1.1	BUND	0.1
BUND 28010.00		1.1	BUND	1.1	BREM	0.0	1.1	BUND	1.1	BUND	0.0
BUND 28105.00		0.9	BUND	0.9	BNE	0.1	0.9	BUND	0.9	BNE	0.0
BUND 28200.00		0.8	BUND	0.8	BREM	0.0	0.8	BNE	0.7	BNE	0.0
BUND 28320.00		0.7	BUND	0.7	BUND	0.0	0.7	BREM	0.7	BNE	0.0
BUND 28440.00		0.9	BUND	0.9	BUND	0.0	0.9	BUND	0.9	BUND	0.0
BUND 28450.00		0.9	BNE	0.9	BUND	0.0	0.9	BUND	0.9	BUND	0.0
BUND 28460.00		1.0	BNE	1.0	BNE	0.0	1.0	BNE	1.0	BUND	0.0
BUND 28470.00		0.9	BUND	0.9	BUND	0.0	0.9	BUND	0.9	BUND	0.0
BUND 28480.00		0.9	BUND	0.9	BUND	0.0	0.9	BUND	0.9	BUND	0.0
BUND 28510.00	Cunningham Hwy	3.0	BUND	2.7	BUND	0.2	2.4	BUND	2.3	BUND	-0.1
BUND 28530.00		1.2	BUND	1.1	BUND	0.0	1.1	BUND	1.1	BUND	0.0
BUND 28535.00		1.0	BNE	1.0	BNE	0.0	1.0	BUND	1.0	BUND	0.0
BUND 28540.00		1.0	BNE	1.0	BNE	0.0	1.0	BUND	1.0	BUND	0.0
BUND 28550.00		0.7	BNE	0.7	BNE	0.0	0.7	BUND	0.7	BUND	0.0
BUND 28560.00		0.6	BNE	0.6	BNE	0.0	0.6	BUND	0.6	BUND	0.0
BUND 28730.00		0.7	BUND	0.7	BUND	0.0	0.7	BUND	0.6	BNE	0.0
BUND 28900.00		0.9	BUND	0.9	BUND	0.0	0.8	BUND	0.9	BUND	0.1
BUND 29070.00		0.8	BUND	0.8	BNE	0.0	0.8	BUND	0.8	BNE	0.0
BUND 29240.00		1.0	BUND	1.1	BREM	0.0	1.0	BUND	1.1	BUND	0.0
BUND 29395.00		1.3	BREM	1.3	BREM	0.0	1.3	BREM	1.3	BREM	0.0
BUND 29560.00		1.9	BNE	1.9	BUND	0.0	1.9	BREM	1.9	BREM	0.0
BUND 29730.00		1.5	BNE	1.5	BUND	0.0	1.5	BREM	1.5	BREM	0.0
BUND 29910.00		2.4	BNE	2.3	BREM	0.0	2.4	BUND	2.4	BUND	0.0
BUND 30062.50		1.5	BNE	1.5	BREM	0.0	1.5	BUND	1.4	BNE	0.0
BUND 30215.00		1.3	BNE	1.2	BNE	0.0	1.1	BNE	1.1	BNE	0.0
BUND 30367.50		1.0	BUND	1.0	BUND	0.0	0.9	BUND	0.9	BNE	0.0
BUND 30520.00		1.6	BUND	2.2	BNE	0.6	1.6	BUND	1.9	BNE	0.3
BUND 30730.00		0.9	BUND	0.8	BNE	0.0	0.8	BUND	0.8	BUND	0.0
BUND 30940.00		1.4	BNE	1.7	BREM	0.3	1.0	BUND	1.3	BUND	0.3
BUND 31150.00		0.7	BUND	0.8	BREM	0.1	0.7	BUND	0.8	BUND	0.1
BUND 31350.00		0.9	BUND	1.0	BUND	0.1	0.8	BUND	1.0	BUND	0.2
BUND 31455.00		1.0	BNE	1.1	BUND	0.1	1.1	BNE	1.1	BUND	0.1
BUND 31630.00		1.6	BUND	1.6	BREM	0.0	1.6	BNE	1.6	BUND	0.0
BUND 31805.00		1.2	BUND	1.2	BREM	0.1	1.1	BUND	1.2	BUND	0.1
BUND 31960.00	Blackstone Rd Bdg	1.5	BNE	0.9	BUND	-0.6	1.3	BNE	1.4	BNE	0.1
BUND 31990.00		2.5	BNE	1.9	BUND	-0.6	2.3	BNE	1.6	BNE	-0.6
BUND 32000.00		1.2	BNE	0.9	BREM	-0.3	1.0	BNE	1.0	BNE	0.1
BUND 32075.00		1.1	BUND	1.1	BUND	0.0	1.1	BUND	1.0	BUND	0.0
BUND 32150.00		2.0	BUND	1.9	BUND	-0.1	1.6	BUND	1.5	BNE	-0.1
BUND 32250.00		1.2	BUND	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
BUND 32350.00	Blackstone Rail Bdg	1.2	BUND	1.2	BUND	0.0	1.1	BUND	1.1	BUND	0.0
BUND 32360.00		2.4	BUND	2.4	BUND	0.0	1.6	BUND	1.4	BNE	-0.2
BUND 32370.00		1.2	BUND	1.2	BUND	0.0	1.1	BUND	1.1	BUND	0.0
BUND 32522.50		1.2	BUND	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
BUND 32675.00		1.3	BUND	1.3	BUND	0.0	1.3	BUND	1.3	BNE	0.0
BUND 32827.50		1.5	BUND	1.5	BUND	0.0	1.4	BUND	1.4	BNE	0.0
BUND 32980.00		1.9	BUND	1.8	BUND	-0.1	1.6	BUND	1.6	BNE	0.0
BUND 33150.00		2.2	BUND	2.1	BUND	-0.1	1.8	BUND	1.8	BNE	-0.1
BUND 33320.00		2.7	BUND	2.6	BUND	-0.1	2.2	BUND	2.1	BNE	-0.1
BUND 33490.00		1.3	BUND	1.3	BUND	-0.1	1.3	BUND	1.2	BUND	-0.1
BUND 33660.00		0.9	BNE	0.9	BNE	0.0	0.9	BUND	0.9	BUND	0.0
BUND 33805.00		1.0	BUND	0.9	BUND	0.0	1.0	BUND	0.9	BUND	0.0
BUND 33950.00		1.1	BUND	1.1	BUND	-0.1	1.0	BUND	1.0	BUND	0.0
BUND 33975.00		1.2	BUND	1.1	BUND	-0.1	1.0	BUND	1.0	BUND	0.0
BUND 34000.00		1.2	BUND	1.1	BUND	-0.1	1.0	BREM	1.0	BREM	0.0
BUND 34130.00		1.2	BUND	1.2	BUND	0.0	1.2	BREM	1.2	BREM	0.0
BUND 34260.00		2.7	BNE	2.8	BNE	0.1	2.4	BNE	2.4	BNE	0.0
BUND 34282.50		1.1	BUND	1.1	BUND	0.0	1.0	BNE	1.0	BUND	0.0
BUND 34305.00		0.8	BREM	0.8	BUND	0.0	0.8	BNE	0.8	BNE	0.0
BUND 34325.00	Brisbane Rd Bdg	3.9	BUND	3.9	BUND	0.0	3.7	BUND	3.3	BNE	-0.4
BUND 34345.00		1.0	BNE	1.0	BNE	0.0	1.0	BUND	1.0	BNE	0.0
BUND 34370.00		1.4	BNE	1.4	BNE	0.0	1.4	BUND	1.4	BNE	0.0
BUND 34395.00		3.6	BUND	3.5	BUND	-0.1	3.0	BUND	2.8	BNE	-0.2
BUND 34577.50		2.1	BUND	2.1	BUND	0.0	2.0	BUND	2.0	BUND	0.0
BUND 34760.00		2.4	BNE	2.4	BNE	-0.1	2.1	BNE	2.1	BNE	0.0
BUND 34905.00		2.3	BNE	2.3	BNE	0.0	2.3	BNE	2.3	BUND	0.0
BUND 35050.00		3.6	BNE	3.6	BNE	0.0	3.6	BNE	3.6	BUND	0.0
BUND 35075.00		2.3	BNE	2.3	BNE	0.0	2.4	BNE	2.3	BREM	0.0
BUND 35100.00	Basketball Hall Bdg	1.8	BUND	1.8	BUND	0.0	1.8	BREM	1.8	BREM	0.0
BUND 35110.00		3.1	BUND	3.1	BUND	-0.1	2.7	BNE	2.7	BNE	0.0
BUND 35120.00		2.0	BNE	2.0	BUND	0.0	2.1	BNE	2.0	BNE	0.0
BUND 35320.00		1.8	BNE	1.8	BNE	0.0	1.8	BUND	1.8	BUND	0.0
BUND 35520.00	Bris-Ips Rail Bdg	2.3	BUND	2.2	BUND	0.0	1.9	BUND	1.8	BUND	-0.1
BUND 35530.00		2.6	BNE	2.7	BNE	0.0	2.1	BUND	2.1	BUND	-0.1
BUND 35540.00		2.4	BUND	2.3	BUND	0.0	1.9	BUND	1.8	BUND	-0.1
BUND 35635.00		2.6	BUND	2.8	BUND	0.0	2.3	BUND	2.3	BUND	-0.1
BUND 35730.00		3.4	BUND	3.5	BUND	0.0	3.4	BNE	3.4	BUND	0.0
BUND 35867.50		2.1	BUND	2.2	BUND	0.1	2.1	BREM	2.1	BREM	0.0
BUND 36005.00	Gladstone St Bdg	1.5	BUND	1.6	BUND	0.0	1.5	BREM	1.5	BREM	0.0
BUND 36015.00		3.1	BUND	3.0	BUND	-0.1	2.4	BUND	2.1	BUND	-0.3

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
BUND 36025.00		1.6	BUND	1.6	BUND	0.0	1.6	BREM	1.6	BREM	0.0
BUND 36161.25		1.8	BUND	1.7	BUND	0.0	1.6	BUND	1.6	BUND	0.0
BUND 36297.50		1.9	BUND	1.9	BUND	0.0	1.8	BUND	1.7	BUND	-0.1
BUND 36433.75		2.5	BUND	2.5	BUND	0.0	2.3	BUND	2.2	BUND	-0.1
BUND 36570.00		3.6	BUND	3.6	BUND	0.0	3.3	BUND	3.2	BUND	-0.1
BUND 36705.00		2.8	BUND	2.8	BUND	0.0	2.6	BUND	2.5	BUND	-0.1
BUND 36840.00		2.3	BUND	2.3	BUND	0.0	2.1	BUND	2.1	BREM	0.0
BUND 36975.00		1.8	BUND	1.8	BUND	0.0	1.6	BUND	1.6	BUND	0.0
BUND 37110.00		1.5	BUND	1.4	BUND	0.0	1.3	BREM	1.3	BUND	0.0
BUND 37285.00		1.6	BUND	1.6	BUND	0.0	1.4	BUND	1.4	BUND	0.0
BUND 37460.00		1.8	BUND	1.7	BUND	0.0	1.6	BUND	1.5	BUND	-0.1
BUND 37635.00		2.0	BUND	2.0	BUND	0.0	1.9	BUND	1.8	BUND	-0.1
BUND 37810.00		2.5	BUND	2.4	BUND	0.0	2.3	BUND	2.3	BUND	-0.1
BUND 37860.00		2.7	BUND	2.7	BUND	0.0	2.6	BUND	2.5	BUND	-0.1
BUND 37910.00		3.0	BUND	3.0	BUND	0.0	2.9	BUND	2.8	BUND	-0.1
BUND 38095.00		2.4	BUND	2.4	BUND	0.0	2.2	BUND	2.2	BUND	-0.1
BUND 38280.00		2.0	BUND	2.0	BUND	0.0	1.8	BUND	1.8	BUND	-0.1
BUND 38501.25		2.1	BUND	2.1	BUND	0.0	1.9	BUND	1.9	BUND	-0.1
BUND 38722.50		2.2	BUND	2.2	BUND	0.0	2.0	BUND	2.0	BUND	-0.1
BUND 38943.75		2.5	BUND	2.5	BUND	0.0	2.4	BUND	2.4	BUND	-0.1
BUND 39165.00		3.1	BUND	3.0	BUND	0.0	3.0	BUND	3.0	BUND	0.0
BUND 39355.83		2.9	BUND	2.9	BUND	0.0	2.7	BUND	2.6	BUND	-0.1
BUND 39546.67		2.8	BUND	2.8	BUND	-0.1	2.6	BUND	2.4	BUND	-0.2
BUND 39737.50		2.6	BUND	2.6	BUND	-0.1	2.3	BUND	2.1	BUND	-0.2
BUND 39920.33		2.4	BUND	2.4	BUND	-0.1	2.0	BUND	1.9	BUND	-0.2
BUND 40119.17		2.2	BUND	2.1	BUND	-0.1	1.9	BUND	1.7	BUND	-0.2
BUND 40310.00		2.1	BUND	2.0	BUND	-0.1	1.7	BUND	1.5	BUND	-0.1
BUND 40490.00		2.4	BUND	2.3	BUND	-0.1	2.0	BUND	1.8	BUND	-0.2
BUND 40670.00		2.9	BUND	2.8	BUND	-0.1	2.5	BUND	2.3	BUND	-0.1
BUND 40850.00		4.4	BUND	4.4	BUND	0.0	3.7	BUND	4.2	BUND	0.4
BUND 41030.00		62.2	BUND	63.8	BUND	1.7	44.2	BUND	57.2	BUND	13.0
HWAY LEFT 0.00		1.1	BUND	1.2	BUND	0.1	1.3	BNE	1.2	BNE	-0.1
HWAY LEFT 85.00		0.5	BUND	0.6	BNE	0.2	0.4	BUND	0.6	BUND	0.2
HWAY LEFT 170.00		0.3	BUND	0.4	BNE	0.1	0.2	BUND	0.4	BUND	0.1
HWAY LEFT 185.00		0.3	BUND	0.4	BNE	0.2	0.2	BUND	0.4	BNE	0.1
HWAY LEFT 200.00		0.3	BUND	0.4	BNE	0.2	0.2	BUND	0.4	BNE	0.2
HWAY LEFT 245.00		0.2	BUND	0.3	BNE	0.1	0.2	BUND	0.3	BUND	0.1
HWAY LEFT 290.00		0.2	BNE	0.2	BUND	0.0	0.2	BUND	0.2	BUND	0.0
HWAY LEFT 300.00		3.7	BUND	3.7	BUND	-0.1	2.2	BUND	2.6	BUND	0.3
HWAY LEFT 310.00		0.6	BUND	0.6	BUND	0.1	0.5	BUND	0.6	BUND	0.1
HWAY LEFT 320.00		0.6	BUND	0.8	BUND	0.2	0.6	BUND	0.8	BUND	0.2
HWAY LEFT 330.00		0.8	BUND	1.0	BUND	0.2	0.7	BUND	1.0	BUND	0.3
HWAY LEFT 360.00		1.1	BUND	1.6	BUND	0.5	0.9	BUND	1.6	BUND	0.7
HWAY LEFT 390.00		2.7	BUND	5.9	BREM	3.2	1.7	BUND	5.5	BUND	3.7
LOWBRANCH1 0.00		1.8	BUND	1.6	BUND	-0.2	1.8	BUND	1.6	BUND	-0.2
LOWBRANCH1 75.00		1.9	BUND	1.8	BUND	-0.1	1.9	BUND	1.7	BUND	-0.1
LOWBRANCH1 150.00		2.3	BUND	2.1	BUND	-0.2	2.2	BUND	2.1	BUND	-0.2
LOWBRANCH1 315.00		1.8	BUND	1.6	BREM	-0.2	1.6	BUND	1.5	BUND	-0.1
LOWBRANCH1 460.00		1.7	BREM	1.4	BREM	-0.3	1.4	BUND	1.3	BUND	-0.2
LOWBRANCH2 0.00		1.1	BUND	1.1	BUND	0.1	1.0	BUND	1.1	BUND	0.2
LOWBRANCH2 120.00		1.3	BUND	1.4	BUND	0.1	1.3	BUND	1.3	BUND	0.0
LOWBRANCH2 240.00		2.2	BNE	2.4	BREM	0.2	2.3	BNE	2.8	BNE	0.5
LOWBRANCH2 490.00		0.8	BUND	1.0	BREM	0.2	0.7	BNE	1.0	BUND	0.3
LOWBRANCH2 740.00		0.5	DEEB	0.5	SIX	0.0	0.6	BREM	0.7	BREM	0.1
UP BRANCH1 0.00		1.8	BUND	1.6	BNE	-0.1	1.7	BNE	1.6	BNE	-0.1
UP BRANCH1 237.50		1.3	BUND	1.6	BNE	0.3	1.2	BUND	1.5	BNE	0.3
UP BRANCH1 475.00		1.4	BUND	2.2	BNE	0.8	1.2	BUND	2.2	BNE	1.0
UP BRANCH1 712.50		1.3	BNE	1.3	BREM	0.1	1.3	BNE	1.3	BUND	0.0
UP BRANCH1 950.00		1.8	BNE	1.8	BUND	0.0	1.8	BNE	1.8	BNE	0.0
UP BRANCH1 1175.00		1.2	BNE	1.2	BUND	0.0	1.2	BUND	1.2	BUND	0.0
UP BRANCH1 1400.00		1.4	BUND	1.3	BUND	-0.1	1.3	BUND	1.3	BUND	0.0
UP BRANCH1 1625.00		0.9	BUND	0.9	BUND	-0.1	0.8	BUND	0.9	BUND	0.1
UP BRANCH1 1850.00		1.0	BUND	0.9	BUND	0.0	0.9	BUND	0.9	BUND	0.1
UP BRANCH1 2070.00		0.2	BUND	0.2	BNE	0.0	0.2	BNE	0.2	BNE	0.0
UP BRANCH1 2220.00		0.1	BUND	0.1	BUND	0.0	0.1	BUND	0.1	BUND	0.0
BUND# 0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUND# 45.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUND# 90.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REEDY 1000.00		1.7	DEEB	1.9	DEEB	0.2	1.4	DEEB	1.5	DEEB	0.2
REEDY 1132.25		1.2	DEEB	1.3	DEEB	0.1	1.0	DEEB	1.2	DEEB	0.1
REEDY 1264.50		0.9	DEEB	1.0	DEEB	0.1	0.8	DEEB	0.9	DEEB	0.1
REEDY 1390.75		1.0	DEEB	1.0	DEEB	0.0	0.8	DEEB	0.9	DEEB	0.1
REEDY 1529.00		1.2	BNE	1.1	DEEB	-0.1	0.8	DEEB	1.0	DEEB	0.1
REEDY 1535.50		1.2	DEEB	1.8	BNE	0.6	1.0	DEEB	1.1	DEEB	0.1
REEDY 1542.00		1.4	DEEB	1.4	DEEB	0.0	1.1	DEEB	1.2	DEEB	0.0
REEDY 1745.00		1.0	DEEB	1.1	DEEB	0.2	0.8	DEEB	1.0	DEEB	0.2
REEDY 1946.00		0.8	DEEB	1.0	DEEB	0.2	0.7	DEEB	0.8	DEEB	0.1
REEDY 2043.50		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REEDY 2139.00		126.0	BNE	157.1	BNE	31.0	51.4	DEEB	69.4	DEEB	18.0
SMALL 1000.00		0.9	DEEB	1.0	DEEB	0.1	0.8	DEEB	0.9	DEEB	0.1
SMALL 1114.00		1.0	DEEB	1.1	DEEB	0.1	1.0	DEEB	1.0	DEEB	0.0
SMALL 1228.00		1.2	BREM	1.2	BREM	0.0	1.2	BNE	1.2	BREM	0.0
SMALL 1242.50		1.4	DEEB	1.4	DEEB	0.1	1.3	DEEB	1.3	DEEB	0.0
SMALL 1257.00		1.7	DEEB	1.8	DEEB	0.1	1.5	DEEB	1.6	DEEB	0.1
SMALL 1333.00		1.9	DEEB	2.0	DEEB	0.1	1.7	DEEB	1.8	DEEB	0.1
SMALL 1409.00		2.1	DEEB	2.2	DEEB	0.1	1.9	BNE	2.0	DEEB	0.1
SMALL 1516.00		1.5	DEEB	1.6	DEEB	0.1	1.4	DEEB	1.5	DEEB	0.1
SMALL 1624.00		1.2	DEEB	1.2	DEEB	0.0	1.1	DEEB	1.2	DEEB	0.0
SMALL 1647.00		1.2	DEEB	1.2	DEEB	0.0	1.1	DEEB	1.1	DEEB	0.0
SMALL 1670.00		1.7	DEEB	1.7	DEEB	0.0	1.6	DEEB	1.6	DEEB	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
SMALL 1779.00		1.5	DEEB	1.6	DEEB	0.1	1.4	DEEB	1.5	DEEB	0.1
SMALL 1888.00		1.6	DEEB	1.7	DEEB	0.1	1.5	DEEB	1.7	DEEB	0.2
SMALL 1939.00		1.3	DEEB	1.3	DEEB	0.1	1.2	DEEB	1.2	DEEB	0.0
SMALL 1990.00		1.6	DEEB	1.5	DEEB	0.0	1.3	DEEB	1.4	DEEB	0.1
SMALL 2059.00		1.5	DEEB	1.7	BREM	0.1	1.1	BNE	1.2	BNE	0.1
SMALL 2128.00		4.6	DEEB	4.5	BREM	0.0	2.6	BNE	2.2	DEEB	-0.3
DEEB 10000.00		0.0	BNE	0.0	BNE	0.0	0.0	BNE	0.0	BNE	0.0
DEEB 10157.50		1.0	DEEB	1.1	DEEB	0.1	0.9	DEEB	0.9	DEEB	0.1
DEEB 10315.00		0.9	DEEB	0.9	DEEB	0.1	0.8	DEEB	0.8	DEEB	0.0
DEEB 10451.75		2.1	DEEB	2.2	DEEB	0.1	1.8	DEEB	1.9	DEEB	0.1
DEEB 10588.50		1.2	DEEB	1.2	DEEB	0.0	1.1	DEEB	1.1	DEEB	0.0
DEEB 10725.25		1.4	DEEB	1.0	DEEB	0.1	1.2	DEEB	1.3	DEEB	0.1
DEEB 10862.00		0.5	DEEB	0.5	DEEB	0.0	0.4	DEEB	0.5	DEEB	0.0
DEEB 11001.50		0.8	DEEB	1.0	DEEB	0.2	0.6	DEEB	0.8	DEEB	0.2
DEEB 11141.00		0.4	DEEB	0.4	DEEB	0.0	0.3	DEEB	0.3	DEEB	0.0
DEEB 11297.00		0.9	DEEB	0.9	DEEB	0.0	0.7	DEEB	0.0	DEEB	0.0
DEEB 11453.00		0.7	DEEB	0.8	BREM	0.0	0.7	DEEB	0.7	DEEB	0.0
DEEB 11645.00		1.3	DEEB	1.5	DEEB	0.1	1.2	DEEB	1.3	DEEB	0.1
DEEB 11837.00		0.7	DEEB	0.8	BREM	0.1	0.7	DEEB	0.7	BNE	0.1
DEEB 11974.00		1.8	DEEB	1.9	DEEB	0.0	1.7	DEEB	1.8	DEEB	0.0
DEEB 12111.00		1.6	DEEB	1.9	BREM	0.3	1.6	DEEB	1.7	BNE	0.1
DEEB 12244.00		2.8	DEEB	2.7	DEEB	0.0	2.5	DEEB	2.6	DEEB	0.1
DEEB 12377.00		1.4	DEEB	1.7	BREM	0.2	1.3	DEEB	1.4	BNE	0.1
DEEB 12510.00		2.7	DEEB	2.7	DEEB	0.1	2.3	DEEB	2.4	DEEB	0.1
DEEB 12643.00		1.9	DEEB	2.1	BREM	0.1	1.8	DEEB	1.9	BNE	0.1
DEEB 12785.00		2.0	DEEB	2.0	DEEB	0.1	1.6	DEEB	1.7	DEEB	0.1
DEEB 12927.00	Cunningham Hwy	0.5	DEEB	0.6	BREM	0.1	0.4	DEEB	0.5	DEEB	0.1
DEEB 12937.00		3.2	DEEB	3.2	DEEB	0.0	2.8	DEEB	2.9	DEEB	0.1
DEEB 12947.00		2.2	DEEB	2.3	DEEB	0.1	1.7	DEEB	1.9	DEEB	0.1
DEEB 13056.00		2.5	DEEB	2.6	DEEB	0.2	2.2	DEEB	2.4	DEEB	0.1
DEEB 13165.00		2.2	DEEB	2.3	DEEB	0.0	2.2	DEEB	2.3	DEEB	0.1
DEEB 13230.00		0.7	DEEB	0.8	DEEB	0.1	0.6	DEEB	0.7	BNE	0.1
DEEB 13295.00		0.3	DEEB	0.3	DEEB	0.0	0.2	DEEB	0.3	DEEB	0.0
DEEB 13441.00		0.6	DEEB	0.6	DEEB	0.0	0.5	DEEB	0.6	DEEB	0.0
DEEB 13587.00		1.0	DEEB	1.0	BREM	0.0	0.9	DEEB	1.0	BNE	0.0
DEEB 13737.50		1.1	DEEB	1.1	DEEB	0.0	1.0	DEEB	1.0	DEEB	0.0
DEEB 13888.00	Ash St Bdg	0.4	DEEB	0.5	BNE	0.0	0.4	DEEB	0.4	BNE	0.1
DEEB 13905.00		3.9	DEEB	4.0	DEEB	0.1	3.4	DEEB	3.5	DEEB	0.1
DEEB 13922.00		1.6	DEEB	1.7	DEEB	0.1	1.3	DEEB	1.4	DEEB	0.1
DEEB 14061.50		1.6	DEEB	1.6	DEEB	0.0	1.3	DEEB	1.4	DEEB	0.0
DEEB 14201.00		1.0	DEEB	1.1	DEEB	0.0	0.9	DEEB	0.9	DEEB	0.1
DEEB 14343.50		1.5	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.3	DEEB	0.0
DEEB 14486.00		1.0	DEEB	1.1	DEEB	0.0	0.9	DEEB	1.0	DEEB	0.0
DEEB 14628.50		1.0	DEEB	1.1	DEEB	0.0	1.0	DEEB	1.0	DEEB	0.0
DEEB 14771.00		1.1	BNE	1.1	BNE	0.0	1.1	BNE	1.1	BNE	0.0
DEEB 14875.00		1.1	DEEB	1.1	DEEB	0.0	1.0	DEEB	1.0	DEEB	0.0
DEEB 14979.00		1.4	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.3	BNE	0.1
DEEB 15069.00		2.1	DEEB	2.1	DEEB	0.1	1.9	DEEB	2.0	DEEB	0.1
DEEB 15159.00		1.7	DEEB	1.7	DEEB	0.1	1.0	DEEB	1.7	BNE	0.1
DEEB 15247.50		1.0	DEEB	1.2	DEEB	0.2	0.9	DEEB	1.0	DEEB	0.0
DEEB 15336.00		0.4	DEEB	0.5	DEEB	0.0	0.4	DEEB	0.4	DEEB	0.0
DEEB 15509.00		0.8	DEEB	0.8	DEEB	0.0	0.7	DEEB	0.7	DEEB	0.0
DEEB 15682.00		0.9	DEEB	0.9	DEEB	0.1	0.8	DEEB	0.9	BNE	0.1
DEEB 15687.00		1.4	DEEB	1.8	BNE	0.4	2.1	BNE	2.2	BNE	0.1
DEEB 15692.00		1.5	DEEB	1.5	DEEB	0.0	1.4	DEEB	1.5	DEEB	0.1
DEEB 15798.00		1.3	DEEB	1.3	DEEB	0.0	1.3	DEEB	1.3	DEEB	0.0
DEEB 15904.00		1.2	BREM	1.3	BREM	0.0	1.2	BNE	1.2	DEEB	0.0
DEEB 15969.50		1.0	BREM	1.0	BREM	0.0	1.0	BNE	1.0	DEEB	0.0
DEEB 16035.00		0.8	DEEB	0.9	DEEB	0.0	0.8	BNE	0.8	DEEB	0.0
DEEB 16116.50		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEEB 16198.00		1.5	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.3	DEEB	0.0
DEEB 16206.50		2.1	DEEB	2.1	DEEB	0.0	1.7	DEEB	1.8	DEEB	0.0
DEEB 16215.00		2.6	DEEB	2.6	DEEB	0.1	2.1	DEEB	2.1	DEEB	0.1
DEEB 16259.00		1.8	DEEB	1.8	DEEB	0.0	1.6	DEEB	1.6	DEEB	0.0
DEEB 16303.00		1.4	DEEB	1.5	DEEB	0.0	1.3	DEEB	1.3	DEEB	0.0
DEEB 16321.50		1.6	DEEB	1.6	DEEB	0.0	1.4	DEEB	1.5	DEEB	0.0
DEEB 16340.00		1.8	DEEB	1.8	DEEB	0.0	1.7	DEEB	1.7	DEEB	0.0
DEEB 16474.50		1.7	DEEB	1.7	DEEB	0.0	1.5	DEEB	1.5	DEEB	0.0
DEEB 16609.00		1.6	DEEB	1.6	DEEB	0.0	1.4	DEEB	1.4	DEEB	0.0
DEEB 16622.00		1.6	DEEB	1.6	DEEB	0.0	1.3	DEEB	1.3	DEEB	0.0
DEEB 16635.00		1.5	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.2	DEEB	0.0
DEEB 16639.00		1.5	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.3	DEEB	0.0
DEEB 16643.00		1.6	DEEB	1.5	DEEB	0.0	1.2	DEEB	1.3	DEEB	0.0
DEEB 16748.50		1.8	DEEB	1.9	DEEB	0.1	1.6	DEEB	1.5	DEEB	0.0
DEEB 16854.00		2.4	DEEB	2.5	DEEB	0.1	1.9	DEEB	2.0	DEEB	0.1
DEEB 16907.00		1.2	DEEB	1.2	DEEB	0.0	1.1	DEEB	1.1	DEEB	0.0
DEEB 16960.00		0.8	DEEB	0.8	DEEB	0.0	0.8	BNE	0.8	BREM	0.0
DEEB 17012.00		0.6	DEEB	0.7	BNE	0.1	0.6	DEEB	0.6	DEEB	0.0
DEEB 17064.00	Warwick Rd Bdg	0.6	DEEB	0.6	DEEB	0.0	0.6	DEEB	0.7	BNE	0.1
DEEB 17072.00		2.4	BNE	2.0	DEEB	-0.4	2.0	BREM	2.6	DEEB	0.6
DEEB 17077.00		0.9	DEEB	0.9	DEEB	0.0	0.9	DEEB	1.2	BNE	0.4
DEEB 17078.50		1.6	BNE	1.5	BNE	-0.1	1.0	DEEB	1.7	DEEB	0.7
DEEB 17080.00		1.2	DEEB	1.3	DEEB	0.0	1.2	DEEB	1.6	BNE	0.4
DEEB 17198.50		1.3	DEEB	1.3	DEEB	0.0	1.1	DEEB	1.2	DEEB	0.0
DEEB 17317.00		1.7	BREM	3.5	BNE	1.9	1.9	DEEB	1.7	DEEB	-0.2
DEEB 17403.00		1.2	DEEB	1.2	DEEB	0.0	1.1	DEEB	1.2	DEEB	0.0
DEEB 17609.00		1.1	DEEB	1.1	DEEB	0.0	1.1	DEEB	1.1	DEEB	0.0
DEEB 17619.00		0.9	DEEB	0.9	DEEB	0.0	0.8	DEEB	0.9	DEEB	0.0
DEEB 17629.00		0.7	DEEB	0.7	DEEB	0.0	0.7	DEEB	0.7	DEEB	0.1
DEEB 17643.00		1.0	DEEB	1.1	DEEB	0.1	0.9	DEEB	1.0	DEEB	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
DEEB 17697.00		1.8	DEEB	2.0	DEEB	0.1	1.7	DEEB	1.8	DEEB	0.1
DEEB 17708.00		3.6	DEEB	3.5	DEEB	0.0	3.3	BREM	3.3	DEEB	0.0
DEEB 17717.00		2.1	DEEB	2.2	DEEB	0.1	2.1	DEEB	2.2	DEEB	0.1
DEEB 17800.50		1.8	DEEB	1.5	DEEB	0.0	1.4	DEEB	1.4	DEEB	0.0
DEEB 17802.00		1.3	DEEB	1.3	DEEB	0.0	1.2	DEEB	1.2	DEEB	0.0
DEEB 17923.00		3.0	BNE	3.1	BNE	0.1	3.1	DEEB	3.1	DEEB	0.0
DEEB 17927.00		1.4	DEEB	1.4	BNE	0.1	1.4	DEEB	1.4	DEEB	0.0
DEEB 18132.00		1.1	BNE	1.1	BNE	0.0	1.1	DEEB	1.1	DEEB	0.0
DEEB 18337.00		1.1	DEEB	1.1	DEEB	0.0	1.0	DEEB	1.0	DEEB	0.0
DEEB 18347.00		1.6	BNE	1.9	BNE	0.3	1.4	DEEB	1.7	BNE	0.3
DEEB 18357.00		0.8	DEEB	0.8	DEEB	0.0	0.7	DEEB	0.7	DEEB	0.0
DEEB 18417.50		1.1	DEEB	1.1	DEEB	0.0	1.0	DEEB	1.0	DEEB	0.0
DEEB 18478.00		1.9	DEEB	1.9	DEEB	0.0	1.7	DEEB	1.7	DEEB	0.1
DEEB 18491.00		4.5	DEEB	4.5	DEEB	0.0	4.1	DEEB	4.2	DEEB	0.1
DEEB 18502.00		3.2	DEEB	3.6	BNE	0.3	7.7	BNE	4.7	BNE	-3.0
DEEB 18547.50		2.7	DEEB	2.7	DEEB	0.0	2.4	DEEB	2.5	DEEB	0.0
DEEB 18593.00		2.4	BNE	2.6	BNE	0.2	2.3	DEEB	2.5	DEEB	0.2
DEEB 18631.50		2.5	DEEB	2.5	DEEB	0.0	2.4	DEEB	2.4	DEEB	0.0
DEEB 18670.00		7.7	BNE	3.4	DEEB	0.7	12.2	BREM	2.6	DEEB	-9.6
DEEB 18732.50		2.1	DEEB	2.2	DEEB	0.0	2.1	DEEB	2.1	DEEB	0.0
DEEB 18795.00		2.6	DEEB	2.0	BNE	-0.7	2.3	BNE	3.5	BREM	1.2
DEEB 18885.50		2.2	DEEB	2.2	DEEB	0.0	2.2	DEEB	2.2	DEEB	0.0
DEEB 18939.00		6.4	BNE	7.6	BNE	1.2	4.2	BNE	3.4	BNE	-0.8
DEEB 19024.00		2.8	DEEB	2.8	DEEB	0.0	2.5	DEEB	2.5	DEEB	0.1
DEEB 19112.00		2.6	DEEB	2.6	DEEB	0.0	2.2	DEEB	2.3	DEEB	0.1
DEEB 19122.00		2.9	DEEB	3.0	DEEB	0.1	1.8	DEEB	2.0	DEEB	0.1
DEEB 19137.00		2.4	DEEB	2.5	DEEB	0.0	2.1	DEEB	2.2	DEEB	0.1
DEEB 19144.50		2.5	DEEB	2.5	DEEB	0.0	2.2	DEEB	2.2	DEEB	0.1
DEEB 19157.00		2.6	DEEB	2.6	DEEB	0.0	2.3	DEEB	2.3	DEEB	0.1
DEEB 19202.00		3.1	DEEB	3.1	DEEB	0.0	2.8	DEEB	2.8	DEEB	0.1
DEEB 19247.00		3.8	DEEB	3.8	DEEB	0.0	3.5	DEEB	3.6	DEEB	0.1
DEEB 19324.00		3.9	DEEB	3.9	DEEB	0.0	3.6	DEEB	3.6	DEEB	0.1
DEEB 19401.00		4.0	DEEB	4.1	DEEB	0.0	3.6	DEEB	3.7	DEEB	0.1
DEEB 19469.00		3.7	DEEB	3.7	DEEB	0.0	3.4	DEEB	3.4	DEEB	0.0
DEEB 19537.00		3.5	DEEB	3.6	DEEB	0.0	3.3	DEEB	3.3	DEEB	0.0
DEEB 19572.00		3.8	DEEB	3.8	DEEB	0.0	3.3	DEEB	3.4	DEEB	0.1
DEEB 19607.00		4.0	DEEB	4.1	DEEB	0.1	3.4	DEEB	3.5	DEEB	0.1
DEEB 19654.50		2.9	DEEB	2.9	DEEB	0.0	2.6	DEEB	2.6	DEEB	0.1
DEEB 19702.00		2.3	DEEB	2.3	DEEB	0.0	2.1	DEEB	2.1	DEEB	0.0
DEEB 19764.50		2.1	DEEB	2.1	DEEB	0.0	1.8	DEEB	1.8	DEEB	0.0
DEEB 19827.00		1.9	DEEB	1.9	DEEB	0.0	1.6	DEEB	1.6	DEEB	0.0
DEEB 19837.00		5.1	DEEB	5.1	DEEB	0.0	4.6	DEEB	4.7	DEEB	0.1
DEEB 19847.00		2.2	DEEB	2.4	DEEB	0.1	1.8	DEEB	1.9	DEEB	0.1
DEEB 19879.50		1.7	DEEB	1.8	DEEB	0.1	1.5	DEEB	1.6	DEEB	0.1
DEEB 19912.00		1.4	DEEB	1.5	DEEB	0.1	1.2	DEEB	1.3	DEEB	0.1
DEEB 19962.00		1.6	DEEB	1.8	DEEB	0.1	1.3	DEEB	1.4	DEEB	0.1
DEEB 20012.00		1.6	DEEB	1.8	DEEB	0.1	2.0	BREM	1.4	DEEB	-0.5
IRON_BR1 1000.00		2.1	IRON	2.3	IRON	0.2	2.0	BNE	2.1	BNE	0.1
IRON_BR1 1164.50		2.0	IRON	2.1	IRON	0.2	1.8	IRON	1.8	IRON	0.1
IRON_BR1 1329.00		2.0	BNE	2.2	BNE	0.2	1.7	IRON	2.2	BNE	0.5
IRON_BR1 1473.50		1.2	IRON	1.2	IRON	0.0	0.9	IRON	0.9	IRON	0.0
IRON_BR1 1618.50		1.7	IRON	1.6	IRON	-0.2	1.2	IRON	1.3	IRON	0.1
IRON_BR1 1735.50		1.1	IRON	1.2	IRON	0.1	1.1	BNE	1.1	BNE	0.0
IRON_BR1 1853.00	Wairuna Ct Bdg	0.7	IRON	0.7	BREM	0.0	0.7	IRON	0.7	IRON	0.0
IRON_BR1 1868.00		4.9	IRON	4.9	IRON	0.0	4.0	IRON	4.1	IRON	0.1
IRON_BR1 1883.00		2.3	IRON	2.4	IRON	0.1	2.0	IRON	2.0	IRON	0.0
IRON_BR1 2022.50		1.2	BNE	1.3	IRON	0.1	1.3	BNE	1.3	BNE	0.0
IRON_BR1 2162.00		1.6	BNE	1.6	BNE	0.0	1.6	BNE	1.6	BNE	0.0
IRON_BR1 2312.50		0.8	BNE	0.9	BNE	0.0	0.7	BNE	0.7	BNE	0.0
IRON_BR1 2463.00		0.6	IRON	0.6	IRON	0.1	0.4	IRON	0.6	IRON	0.0
IRON_BR1 2477.00		0.6	IRON	0.7	IRON	0.1	0.5	IRON	0.5	IRON	0.0
IRON_BR1 2491.00		0.7	IRON	0.7	IRON	0.1	0.5	IRON	0.8	IRON	0.0
IRON 10000.00		0.6	BNE	0.6	BNE	0.0	0.6	BNE	0.6	BNE	0.0
IRON 10137.00		1.5	BNE	1.5	BNE	0.0	1.6	BNE	1.6	BNE	0.0
IRON 10274.00		0.6	IRON	0.6	IRON	0.0	0.5	IRON	0.5	IRON	0.0
IRON 10418.50		1.1	IRON	1.2	IRON	0.0	1.0	IRON	1.0	IRON	0.0
IRON 10563.00		0.5	IRON	0.5	IRON	0.0	0.6	BREM	0.6	BREM	0.0
IRON 10644.00		1.3	IRON	1.4	BNE	0.1	1.2	BNE	1.2	BNE	0.0
IRON 10725.00		1.0	IRON	1.0	IRON	0.0	0.9	BNE	0.9	BNE	0.0
IRON 10863.00		1.4	IRON	1.5	IRON	0.1	1.3	IRON	1.3	IRON	0.0
IRON 11001.00		1.2	IRON	1.2	IRON	0.0	1.1	IRON	1.1	IRON	0.0
IRON 11187.50		1.1	BNE	1.4	BREM	0.3	1.1	BNE	1.3	BNE	0.2
IRON 11374.00		1.5	BNE	2.5	BNE	1.0	1.7	BNE	2.4	BNE	0.7
IRON 11358.00		1.1	IRON	1.2	IRON	0.0	1.0	IRON	1.0	IRON	0.0
IRON 11422.00		1.3	IRON	1.3	IRON	0.0	1.2	IRON	1.2	IRON	0.0
IRON 11593.50		1.2	IRON	1.2	IRON	0.0	1.1	IRON	1.1	IRON	0.0
IRON 11765.00		1.1	IRON	1.1	IRON	0.0	1.0	IRON	1.0	IRON	0.0
IRON 11779.50		0.9	IRON	1.0	IRON	0.0	0.8	IRON	0.8	IRON	0.0
IRON 11794.00		1.0	IRON	1.1	IRON	0.0	0.8	IRON	0.9	IRON	0.1
IRON 11923.00		0.7	IRON	0.7	IRON	0.0	0.7	IRON	0.7	IRON	0.0
IRON 12052.00		1.0	IRON	1.0	IRON	0.0	1.0	IRON	1.0	IRON	0.0
IRON 12193.50		1.6	IRON	1.7	IRON	0.0	1.6	IRON	1.6	IRON	0.0
IRON 12335.00		2.0	IRON	2.0	IRON	0.0	1.9	IRON	1.9	IRON	0.0
IRON 12476.50		1.8	IRON	1.9	IRON	0.0	1.8	IRON	1.8	IRON	0.0
IRON 12618.00	Warrego Hwy	1.9	IRON	2.0	IRON	0.0	1.7	IRON	1.8	IRON	0.0
IRON 12641.00		3.5	IRON	3.6	IRON	0.1	3.1	IRON	3.1	IRON	0.0
IRON 12658.00		2.5	IRON	2.6	IRON	0.1	2.1	IRON	2.1	IRON	0.0
IRON 12810.25		1.5	IRON	1.5	IRON	0.1	1.2	IRON	1.3	IRON	0.0
IRON 12962.50		1.1	IRON	1.2	IRON	0.0	0.9	IRON	0.9	IRON	0.0
IRON 13114.75		1.1	IRON	1.2	IRON	0.0	1.0	IRON	1.0	IRON	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
IRON 13207.00		1.2	IRON	1.3	IRON	0.0	1.1	IRON	1.1	IRON	0.0
IRON 13516.50		1.3	IRON	1.3	IRON	0.0	1.1	IRON	1.1	IRON	0.0
IRON 13766.00		1.2	IRON	1.3	IRON	0.1	1.1	IRON	1.1	IRON	0.0
IRON 13936.60		1.2	IRON	1.2	IRON	0.0	1.0	IRON	1.0	IRON	0.0
IRON 14107.00		1.4	IRON	1.5	IRON	0.0	1.3	IRON	1.3	IRON	0.0
IRON 14281.50		1.7	IRON	1.8	IRON	0.0	1.6	IRON	1.6	IRON	0.0
IRON 14456.00		1.8	IRON	1.9	IRON	0.1	1.6	IRON	1.6	IRON	0.0
IRON 14630.50		2.3	IRON	2.4	IRON	0.1	2.0	IRON	2.0	IRON	0.0
IRON 14805.00		3.3	IRON	3.4	IRON	0.1	2.8	IRON	2.9	IRON	0.0
IRON 14972.00		1.1	IRON	1.1	IRON	0.1	0.9	IRON	0.9	IRON	0.0
IRON 15139.00		0.6	IRON	0.7	IRON	0.0	0.5	IRON	0.5	IRON	0.0
IRON 15273.00		0.8	IRON	0.8	IRON	0.0	0.7	IRON	0.7	IRON	0.0
IRON 15407.00		1.3	IRON	1.4	IRON	0.0	1.1	IRON	1.1	IRON	0.0
IRON 15553.50		1.6	IRON	1.7	IRON	0.0	1.4	IRON	1.4	IRON	0.0
IRON 15700.00		2.1	IRON	2.1	IRON	0.0	1.8	IRON	1.8	IRON	0.0
IRON 15793.50		1.9	IRON	2.0	IRON	0.0	1.7	IRON	1.7	IRON	0.0
IRON 15887.00		1.9	IRON	1.9	IRON	0.0	1.7	IRON	1.7	IRON	0.0
IRON 16042.75		1.8	IRON	1.8	IRON	0.0	1.6	IRON	1.6	IRON	0.0
IRON 16199.50		1.8	IRON	1.8	IRON	0.0	1.6	IRON	1.6	IRON	0.0
IRON 16354.25		2.2	IRON	2.2	IRON	0.0	2.0	IRON	2.0	IRON	0.0
IRON 16510.00		2.9	IRON	2.9	IRON	0.0	2.6	IRON	2.6	IRON	0.0
IRON 16668.50		2.4	IRON	2.4	IRON	0.1	2.3	IRON	2.3	IRON	0.0
IRON 16827.00		2.2	IRON	2.2	IRON	0.0	2.1	IRON	2.1	IRON	0.0
IRON 16960.00		1.8	IRON	1.8	IRON	0.1	1.6	IRON	1.6	IRON	0.0
IRON 17093.00		1.7	IRON	1.7	IRON	0.0	1.5	IRON	1.5	IRON	0.0
IRON 17214.50		2.1	IRON	2.2	IRON	0.0	1.9	IRON	1.9	IRON	0.0
IRON 17336.00		2.5	IRON	2.6	IRON	0.0	2.2	IRON	2.2	IRON	0.0
IRON 17482.00		2.4	IRON	2.4	IRON	0.0	2.1	IRON	2.1	IRON	0.0
IRON 17628.00		2.2	IRON	2.3	IRON	0.0	2.0	IRON	2.0	IRON	0.0
IRON 17756.00		2.5	IRON	2.5	IRON	0.0	2.2	IRON	2.2	IRON	0.0
IRON 17884.00		2.8	IRON	2.8	IRON	0.0	2.6	IRON	2.6	BNE	0.0
IRON 17957.50		2.6	IRON	2.7	IRON	0.1	2.5	IRON	2.5	BNE	0.0
IRON 18031.00		3.1	IRON	2.9	IRON	-0.1	2.7	IRON	2.7	IRON	0.0
IRON 18093.50		1.7	IRON	1.9	IRON	0.2	1.5	IRON	1.6	IRON	0.1
IRON 18156.00		1.7	IRON	1.5	IRON	-0.2	1.2	IRON	1.3	IRON	0.1
IRON 18209.50		1.5	IRON	1.6	IRON	0.1	1.4	IRON	1.4	IRON	0.1
IRON 18263.00		2.8	IRON	2.8	BREM	0.0	2.0	IRON	2.1	BNE	0.1
IRON 18313.00		1.6	BREM	1.5	BNE	0.0	1.6	BNE	1.6	IRON	0.0
IRON 18363.00	Sydney St Bdg	1.4	BREM	1.3	BNE	-0.1	1.4	BNE	1.3	BNE	0.0
IRON 18375.00		6.3	IRON	6.3	BNE	0.0	6.3	IRON	6.3	IRON	0.0
IRON 18384.00		8.3	IRON	7.6	BREM	-0.7	4.7	IRON	6.9	IRON	1.2
IRON 18484.00		2.5	IRON	2.5	IRON	0.0	2.1	IRON	2.1	IRON	0.0
IRON 18584.00		1.7	IRON	1.7	IRON	0.0	1.3	IRON	1.4	IRON	0.0
MHI 10030.00		0.2	BNE	0.2	BNE	0.0	0.2	BNE	0.2	BNE	0.0
MHI 10095.00		1.7	MHI	1.8	MHI	0.0	1.5	MHI	1.5	MHI	0.0
MHI 10192.00		1.3	MHI	1.3	MHI	0.0	1.1	MHI	1.1	MHI	0.0
MHI 10352.50		1.9	MHI	2.0	MHI	0.1	1.7	MHI	1.7	MHI	0.0
MHI 10513.00		0.7	BNE	0.8	MHI	0.0	0.6	MHI	0.6	MHI	0.0
MHI 10612.00		1.7	MHI	1.8	MHI	0.1	1.6	MHI	1.7	MHI	0.0
MHI 10711.00	Ips-Warrego Connect	0.6	MHI	0.6	MHI	0.0	0.5	MHI	0.5	MHI	0.0
MHI 10728.00		3.4	MHI	3.6	MHI	0.1	2.9	MHI	2.9	MHI	0.0
MHI 10747.00		2.4	MHI	2.5	MHI	0.2	2.0	MHI	2.0	MHI	0.0
MHI 10817.00		1.9	BREM	2.0	MHI	0.1	1.7	MHI	1.8	MHI	0.0
MHI 10887.00		1.4	BNE	1.2	BNE	-0.2	1.4	BNE	1.2	BNE	-0.2
MHI 10958.50		1.3	BNE	1.4	BREM	0.0	1.3	BNE	1.3	MHI	0.0
MHI 11030.00		1.2	MHI	1.3	MHI	0.0	1.2	BNE	1.2	MHI	0.0
MHI 11073.50		2.0	MHI	2.0	MHI	0.0	1.9	MHI	1.9	MHI	0.0
MHI 11117.00		2.5	MHI	2.6	MHI	0.1	2.2	MHI	2.3	MHI	0.0
MHI 11197.00		1.6	MHI	1.7	MHI	0.1	1.5	MHI	1.5	MHI	0.1
MHI 11277.00	Hunter St	1.2	MHI	1.2	MHI	0.0	1.2	MHI	1.2	MHI	0.0
MHI 11296.00		4.1	MHI	4.1	MHI	0.0	3.8	MHI	3.9	MHI	0.1
MHI 11310.00		3.6	MHI	3.6	MHI	0.1	2.9	MHI	3.0	MHI	0.1
MHI 11389.00		1.7	MHI	1.8	MHI	0.1	1.6	MHI	1.6	MHI	0.1
MHI 11458.00		3.3	BNE	3.6	BNE	0.1	2.6	BNE	2.7	BNE	0.1
MHI 11588.00		1.3	MHI	1.2	BNE	-0.1	1.2	MHI	1.2	BNE	0.0
MHI 11708.00		4.7	BNE	4.6	BNE	-0.1	3.8	MHI	3.7	BNE	-0.1
MHI 11838.00		1.5	MHI	1.6	MHI	0.1	1.4	MHI	1.4	MHI	0.0
MHI 11968.00		2.4	MHI	2.5	MHI	0.1	2.2	MHI	2.3	MHI	0.0
MHI 12051.50		2.2	MHI	2.3	MHI	0.0	2.0	MHI	2.0	MHI	0.0
MHI 12135.00		2.2	MHI	2.2	MHI	0.0	1.8	MHI	2.0	MHI	0.0
MHI 12182.50		2.2	MHI	2.2	MHI	0.0	1.9	MHI	2.0	MHI	0.0
MHI 12230.00		2.2	MHI	2.2	MHI	0.0	1.9	MHI	1.9	MHI	0.0
MHI 12357.50		2.6	MHI	2.5	MHI	0.0	2.2	MHI	2.2	MHI	0.0
MHI 12485.00		2.9	MHI	2.9	MHI	0.0	2.6	MHI	2.6	MHI	0.0
MHI 12557.50		2.6	MHI	2.6	MHI	0.0	2.3	MHI	2.3	MHI	0.0
MHI 12630.00		2.3	MHI	2.3	MHI	0.0	2.0	MHI	2.1	MHI	0.0
MHI 12697.00		2.0	MHI	2.8	MHI	0.0	2.6	MHI	2.6	MHI	0.0
MHI 12764.00		3.7	MHI	3.8	MHI	0.0	3.2	MHI	3.3	MHI	0.1
MHI 12842.50		4.0	MHI	4.1	MHI	0.0	3.6	MHI	3.6	MHI	0.1
MHI 12921.00		4.3	MHI	6.4	BNE	1.1	3.8	MHI	3.9	MHI	0.1
MHI 13020.50		1.9	MHI	2.0	MHI	0.1	1.4	MHI	1.5	MHI	0.1
MHI 13120.00		1.2	MHI	1.3	MHI	0.1	0.9	MHI	1.0	MHI	0.1
MHI_BR1 1292.00		0.0	BNE	0.0	BNE	0.0	0.0	BNE	0.0	BNE	0.0
MHI_BR1 1322.00		0.4	MHI	0.3	BREM	0.0	0.3	BNE	0.3	MHI	0.0
MHI_BR1 1352.00		0.1	BREM	0.1	BREM	0.0	0.1	BREM	0.1	BREM	0.0
MHI_BR1 1382.00	Warrego Hway	3.1	MHI	3.1	MHI	0.0	2.7	MHI	2.7	MHI	0.1
MHI_BR1 1412.00		1.1	MHI	1.3	MHI	0.2	0.9	MHI	0.9	BNE	0.0
MHI_BR1 1441.50		1.4	MHI	1.4	MHI	0.0	1.3	BNE	1.4	BNE	0.1
MHI_BR1 1471.00		2.1	BNE	1.5	BNE	0.6	2.2	BNE	1.5	BNE	-0.7
MHI_BR1 1640.00		1.4	MHI	1.6	MHI	0.1	1.3	MHI	1.3	MHI	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model Location	Location Description	100y ARI (Existing) [m/s]		100y ARI (Ultimate) [m/s]		Diff [m/s]	20y ARI (Existing) [m/s]		20y ARI (Ultimate) [m/s]		Diff [m/s]
MIHI_BR1 1627.00		0.9	MIHI	1.1	MIHI	0.1	0.8	MIHI	0.8	MIHI	0.0
MIHI_BR1 1949.50		0.5	MIHI	0.4	MIHI	0.0	0.4	MIHI	0.4	MIHI	0.0
MIHI_BR1 2072.00		0.7	MIHI	0.7	MIHI	0.0	0.6	MIHI	0.6	MIHI	0.0
MIHI_BR1 2209.00		1.7	MIHI	1.7	MIHI	0.0	1.4	MIHI	1.5	MIHI	0.0
MIHI_BR1 2346.00		2.1	MIHI	2.2	MIHI	0.1	1.9	MIHI	1.9	MIHI	0.1
MIHI_BR1 2454.50		1.7	MIHI	1.8	MIHI	0.1	1.4	MIHI	1.5	MIHI	0.0
MIHI_BR1 2563.00	Pine Mountain Rd	1.0	MIHI	1.0	MIHI	0.0	1.0	MIHI	1.0	MIHI	0.0
MIHI_BR1 2580.00		3.0	MIHI	3.1	MIHI	0.0	2.6	MIHI	2.6	MIHI	0.0
MIHI_BR1 2597.00		2.0	MIHI	2.0	MIHI	0.1	1.7	MIHI	1.7	MIHI	0.0
MIHI_BR1 2648.50		0.9	MIHI	0.9	MIHI	0.0	0.7	MIHI	0.7	MIHI	0.0
MIHI_BR1 2700.00		0.6	MIHI	0.5	MIHI	0.0	0.5	BREM	0.6	BREM	0.0
SCH 10000.00		0.1	BNE	0.1	BNE	0.0	0.1	BNE	0.1	BNE	0.0
SCH 10170.00		2.0	SCH	2.0	SCH	0.0	1.8	SCH	2.0	SCH	0.2
SCH 10340.00		1.4	BNE	1.5	BNE	0.1	1.2	BREM	1.2	BREM	0.0
SCH 10570.00		2.0	SCH	2.0	SCH	0.0	1.7	SCH	2.0	SCH	0.3
SCH 10800.00	Robin St	0.2	SCH	0.2	SCH	0.0	0.2	SCH	0.2	SCH	0.1
SCH 10805.00		2.6	SCH	2.6	SCH	0.0	2.2	SCH	2.6	SCH	0.4
SCH 10910.00		4.0	BNE	4.0	BNE	0.0	3.8	BNE	3.8	BNE	0.0
SCH 10960.00		1.0	SCH	1.0	SCH	0.0	0.9	SCH	1.0	SCH	0.1
SCH 11110.00		0.6	SCH	0.6	SCH	0.0	0.5	SCH	0.6	SCH	0.1
SCH 11246.40		1.0	SCH	1.0	SCH	0.0	0.9	SCH	1.0	SCH	0.1
SCH 11382.80		0.7	SCH	0.7	SCH	0.0	0.6	SCH	0.7	SCH	0.1
SCH 11496.40		1.6	SCH	1.5	SCH	0.0	1.3	SCH	1.6	SCH	0.2
SCH 11610.00		2.9	SCH	2.9	SCH	0.0	2.8	SCH	2.9	SCH	0.3
SCH 11748.60		1.6	SCH	1.6	SCH	0.0	1.6	SCH	1.6	SCH	0.2
SCH 11887.00	Warrego Hway	0.6	SCH	0.6	SCH	0.0	0.6	SCH	0.6	SCH	0.0
SCH 11907.00		4.5	SCH	4.5	SCH	0.0	3.8	SCH	4.5	SCH	0.7
SCH 11927.00		1.1	SCH	1.1	SCH	0.0	0.9	SCH	1.1	SCH	0.2
SCH 12047.00		1.4	SCH	1.4	SCH	0.0	1.1	SCH	1.4	SCH	0.2
SCH 12167.00		1.3	SCH	1.3	SCH	0.0	1.1	SCH	1.3	SCH	0.2
SCH 12227.00		1.7	SCH	1.7	SCH	0.0	1.6	SCH	1.7	SCH	0.1
SCH 12207.00		1.6	SCH	1.6	SCH	0.0	1.6	BNE	1.5	SCH	0.0
SCH 12361.00		1.4	SCH	1.4	SCH	0.0	1.3	BNE	1.4	SCH	0.0
SCH 12435.00	Mt Crosby Rd	0.9	SCH	0.9	SCH	0.0	0.8	SCH	0.9	SCH	0.1
SCH 12449.00		3.9	SCH	3.9	SCH	0.0	2.6	SCH	3.9	SCH	1.3
SCH 12462.80		1.6	SCH	1.6	SCH	0.0	1.4	SCH	1.6	SCH	0.2
SCH 12634.20		1.8	SCH	1.8	SCH	0.0	1.7	SCH	1.8	SCH	0.2
SCH 12805.60		1.6	SCH	1.6	SCH	0.0	1.6	SCH	1.6	SCH	0.0
SCH 12927.80		1.3	SCH	1.3	SCH	0.0	1.1	SCH	1.3	SCH	0.2
SCH 13050.00		1.0	SCH	1.0	SCH	0.0	0.8	SCH	1.0	SCH	0.2
SCH 13055.00		1.0	SCH	1.0	SCH	0.0	0.8	SCH	1.0	SCH	0.2
SCH 13060.00		1.0	SCH	1.0	SCH	0.0	0.8	SCH	1.0	SCH	0.2
SCH 13134.50		1.3	SCH	1.3	SCH	0.0	1.1	SCH	1.3	SCH	0.3
SCH 13209.00		1.8	SCH	1.8	SCH	0.0	1.6	SCH	1.8	SCH	0.2
SCH 13403.75		1.7	SCH	1.7	SCH	0.0	1.6	SCH	1.7	SCH	0.2
SCH 13598.50		1.7	SCH	1.7	SCH	0.0	1.5	SCH	1.7	SCH	0.2
SCH 13874.25		2.1	SCH	2.1	SCH	0.0	1.9	SCH	2.1	SCH	0.3
SCH 13750.00		3.0	SCH	3.0	SCH	0.0	2.6	SCH	3.0	SCH	0.4
SCH 13753.50		3.1	SCH	3.1	SCH	0.0	2.7	SCH	3.1	SCH	0.4
SCH 13757.00		3.3	SCH	3.3	SCH	0.0	2.8	SCH	3.3	SCH	0.5
SCH 13864.50		4.7	SCH	4.7	SCH	0.0	3.8	SCH	4.7	SCH	0.9
SCH 13972.00		8.7	SCH	8.7	SCH	0.0	6.0	SCH	8.7	SCH	2.8
MIHI_LINK1 0.00		0.0	BNE	0.1	BNE	0.0	0.0	0.0	0.0	0.0	0.0
MIHI_LINK1 15.00		0.0	BNE	0.0	BNE	0.0	0.0	0.0	0.0	0.0	0.0
MIHI_LINK1 30.00		0.0	BNE	0.1	BNE	0.0	0.0	0.0	0.0	0.0	0.0
SCH_LK1 0.00		0.0	0.0	0.0	0.0	0.0	0.1	BNE	0.1	BNE	0.0
SCH_LK1 15.00		0.0	0.0	0.0	0.0	0.0	0.6	BNE	0.6	BNE	0.0
SCH_LK1 30.00		0.0	0.0	0.0	0.0	0.0	0.1	BNE	0.1	BNE	0.0
DEEB_LK1 0.00		843.7	BREM	856.3	BREM	12.6	736.1	BNE	722.9	BNE	-13.2
DEEB_LK1 15.00		2.5	BREM	2.5	BNE	-0.1	2.4	BREM	2.3	BNE	0.0
DEEB_LK1 30.00		843.7	BREM	856.3	BREM	12.6	736.1	BNE	722.9	BNE	-13.2
DEEB_LK2 0.00		1225.7	BREM	1200.4	BREM	-25.2	227.6	BNE	186.2	BNE	-41.4
DEEB_LK2 15.00		3.0	BREM	3.0	BREM	0.0	2.8	BNE	2.7	BNE	-0.1
DEEB_LK2 30.00		1225.7	BREM	1200.4	BREM	-25.2	227.6	BNE	186.2	BNE	-41.4
DEEB_LK3 0.00		240.6	BNE	206.3	BNE	-34.4	0.0	0.0	0.0	0.0	0.0
DEEB_LK3 15.00		2.5	BREM	2.5	BREM	0.0	0.0	0.0	0.0	0.0	0.0
DEEB_LK3 30.00		240.6	BNE	206.3	BNE	-34.4	0.0	0.0	0.0	0.0	0.0
DEEB_LK4 0.00		40.6	BNE	40.1	BNE	-0.4	17.0	BNE	17.3	BNE	-0.6
DEEB_LK4 15.00		2.8	BNE	2.8	BNE	0.0	2.6	DEEB	2.6	DEEB	0.0
DEEB_LK4 30.00		40.6	BNE	40.1	BNE	-0.4	17.6	BNE	17.3	BNE	-0.6
DEEB_LK5 0.00		24.3	BNE	22.6	BREM	-1.7	0.0	BNE	0.0	BNE	0.0
DEEB_LK5 15.00		0.1	BREM	0.1	BREM	0.0	0.1	BNE	0.1	BNE	0.0
DEEB_LK5 30.00		24.3	BNE	22.6	BREM	-1.7	0.0	BNE	0.0	BNE	0.0
DEEB_LK7 0.00		0.0	BNE	0.0	BNE	0.0	0.0	0.0	0.0	0.0	0.0
DEEB_LK7 15.00		0.5	BNE	0.6	BNE	0.0	0.0	0.0	0.0	0.0	0.0
DEEB_LK7 30.00		0.0	BNE	0.0	BNE	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK1 0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK1 15.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK1 30.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK2 0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK2 15.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOG_LK2 30.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEEB_LK6 0.00		4.7	BREM	4.4	BREM	-0.3	0.0	0.0	0.0	0.0	0.0
DEEB_LK6 15.00		0.0	BREM	0.0	BREM	0.0	0.0	0.0	0.0	0.0	0.0
DEEB_LK6 30.00		4.7	BREM	4.4	BREM	-0.3	0.0	0.0	0.0	0.0	0.0
BREMBRIS2 0.00		642.2	BREM	613.3	BNE	-29.0	343.9	BNE	335.7	BNE	-8.2
BREMBRIS2 71.09		7.4	BNE	7.4	BNE	0.0	7.4	BNE	7.4	BNE	0.0
BREMBRIS2 142.18		642.2	BREM	613.3	BNE	-29.0	343.9	BNE	335.7	BNE	-8.2
SCH_LK2 0.00		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCH_LK2 30.83		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table G-3: Predicted Peak Velocities and Comparison - 100 & 20 Year ARI Events

Mike11 Model	Location	100y ARI (Existing)		100y ARI (Ultimate)		Diff	20y ARI (Existing)		20y ARI (Ultimate)		Diff
Location	Description	(m/s)		(m/s)		(m/s)	(m/s)		(m/s)		(m/s)
SCH_LK2 61.66		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix H - Pervious & Impervious Areas

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

	Pervious Area			Impervious Area		
Link Label	Exist (Ha)	Ultimate (Ha)	Difference (Ha)	Exist (Ha)	Ultimate (Ha)	Difference (Ha)
1A	931.6	464.5	467.1	78.6	545.7	-467.1
1B	1628.0	748.2	879.8	182.8	1062.6	-879.8
2B	124.5	78.4	46.1	32.3	78.4	-46.1
2C	511.7	389.9	121.8	268.1	389.9	-121.8
2C#	0.2	0.1	0.1	0.0	0.0	0.0
2D	550.1	336.3	213.8	122.6	336.3	-213.8
5B	340.0	224.0	116.1	107.9	224.0	-116.1
5C	486.0	335.2	150.8	30.7	181.5	-150.8
6A	984.0	929.0	55.0	0.0	55.0	-55.0
6B	307.0	232.0	75.0	0.0	75.0	-75.0
6C	1540.2	993.2	547.0	60.0	607.0	-547.0
6D	326.1	279.5	46.6	12.9	59.5	-46.6
6E	843.5	581.5	262.0	13.5	295.5	-282.0
6F	122.0	120.0	2.0	0.0	2.0	-2.0
AMB#	10.0	10.0	0.0	0.0	0.0	0.0
AMB1	7621.0	7621.0	0.0	0.0	0.0	0.0
AMB2	6290.0	6290.0	0.0	0.0	0.0	0.0
AMB3	5954.0	5954.0	0.0	0.0	0.0	0.0
AMB4	2762.0	2702.0	0.0	0.0	0.0	0.0
AMB5	8526.0	8526.0	0.0	0.0	0.0	0.0
AMB6	6631.0	6631.0	0.0	0.0	0.0	0.0
AMB7	6936.0	4247.0	2689.0	0.0	2689.0	-2689.0
AMB-OUT	10.0	10.0	0.0	0.0	0.0	0.0
BD#	0.2	0.2	0.0	0.0	0.0	0.0
BD##	10.0	10.0	0.0	0.0	0.0	0.0
BD###	0.2	0.2	0.0	0.0	0.0	0.0
BD####	0.2	0.2	0.0	0.0	0.0	0.0
BD#####	10.0	10.0	0.0	0.0	0.0	0.0
BD######	0.2	0.2	0.0	0.0	0.0	0.0
BUL#	10.0	10.0	0.0	0.0	0.0	0.0
BUL1	2533.0	2533.0	0.0	0.0	0.0	0.0
BUL2	1591.0	1591.0	0.0	0.0	0.0	0.0
BUL3	2386.0	2386.0	0.0	0.0	0.0	0.0
BUL4	1672.0	1672.0	0.0	0.0	0.0	0.0
BUL5	2040.0	2040.0	0.0	0.0	0.0	0.0
BUL6	1402.0	1402.0	0.0	0.0	0.0	0.0
BUL7	1500.0	1600.0	0.0	0.0	0.0	0.0
BUL-OUT	10.0	10.0	0.0	0.0	0.0	0.0
BUND1	2068.8	2068.8	0.0	0.0	0.0	0.0
BUND10	633.1	409.6	223.5	176.5	400.0	-223.5
BUND11	8.1	97.8	-89.7	182.2	92.5	89.7
BUND12	207.6	201.3	6.3	195.0	201.3	-6.3
BUND13	160.0	91.8	68.3	23.5	91.8	-68.3
BUND14	155.0	151.4	3.6	147.8	151.4	-3.6
BUND15	137.9	70.7	67.2	3.5	70.7	-67.2
BUND2	658.1	658.1	0.0	0.0	0.0	0.0
BUND3	2164.0	1734.0	430.0	0.0	430.0	-430.0
BUND4	1158.0	698.0	460.0	0.0	460.0	-460.0
BUND5	1225.0	1059.0	166.0	0.0	166.0	-166.0
BUND6	565.9	300.4	265.5	34.5	300.0	-265.5
BUND7	708.2	354.1	354.1	0.0	354.1	-354.1
BUND8	276.5	141.2	135.3	5.2	141.8	-136.6
BUND9	366.0	282.1	83.9	197.6	281.5	-83.9
COO+	10.0	10.0	0.0	0.0	0.0	0.0
COO1	4553.0	4553.0	0.0	0.0	0.0	0.0
COO10	11122.0	11122.0	0.0	0.0	0.0	0.0
COO11	9223.0	9223.0	0.0	0.0	0.0	0.0
COO12	4837.0	4837.0	0.0	0.0	0.0	0.0
COO13	6721.0	6721.0	0.0	0.0	0.0	0.0
COO2	3175.0	3175.0	0.0	0.0	0.0	0.0
COO3	8282.0	8282.0	0.0	0.0	0.0	0.0
COO4	7628.0	7628.0	0.0	0.0	0.0	0.0
COO5	10366.0	10366.0	0.0	0.0	0.0	0.0
COO6	10195.0	10195.0	0.0	0.0	0.0	0.0
COO7	6781.0	6781.0	0.0	0.0	0.0	0.0
COO8	7565.0	7565.0	0.0	0.0	0.0	0.0
COO9	7255.0	7265.0	0.0	0.0	0.0	0.0

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

Link Label	Pervious Area			Impervious Area		
	Exist (Ha)	Ultimate (Ha)	Difference (Ha)	Exist (Ha)	Ultimate (Ha)	Difference (Ha)
COO-OUT	10.0	10.0	0.0	0.0	0.0	0.0
CRE#	10.0	10.0	0.0	0.0	0.0	0.0
CRE1	3999.0	3999.0	0.0	0.0	0.0	0.0
CRE2	5844.0	5844.0	0.0	0.0	0.0	0.0
CRE3	4484.0	4484.0	0.0	0.0	0.0	0.0
CRE4	7302.0	7302.0	0.0	0.0	0.0	0.0
CRE5	206.2	206.2	0.0	0.0	0.0	0.0
CRE6	6408.0	6408.0	0.0	0.0	0.0	0.0
CRE7	523.4	523.4	0.0	0.0	0.0	0.0
CRE-OUT	10.0	10.0	0.0	0.0	0.0	0.0
DB#	0.2	0.2	0.0	0.0	0.0	0.0
DB##	0.2	0.2	0.0	0.0	0.0	0.0
DB###	0.2	0.2	0.0	0.0	0.0	0.0
DB####	0.2	0.2	0.0	0.0	0.0	0.0
DB1	955.0	583.0	372.0	0.0	372.0	-372.0
DB10	69.1	48.7	20.4	28.3	48.7	-20.4
DB11	94.6	59.2	35.4	23.8	59.2	-35.4
DB2	340.6	170.3	170.3	0.0	170.3	-170.3
DB3	66.7	54.2	12.5	41.6	54.2	-12.5
DB4	90.2	61.1	29.1	28.9	58.0	-29.1
DB5	289.4	175.2	114.2	61.0	175.2	-114.2
DB6	98.5	63.8	34.7	29.1	63.8	-34.7
DB7	50.7	28.2	22.5	5.6	28.2	-22.5
DB8	168.1	120.1	48.0	72.1	120.1	-48.0
DB9	94.7	65.8	28.9	36.8	65.8	-28.9
DB-OUT	0.2	0.2	0.0	0.0	0.0	0.0
EMU+	10.0	10.0	0.0	0.0	0.0	0.0
EMU++	10.0	10.0	0.0	0.0	0.0	0.0
EMU1	9514.0	9514.0	0.0	0.0	0.0	0.0
EMU10	6799.0	6799.0	0.0	0.0	0.0	0.0
EMU11	7906.0	7906.0	0.0	0.0	0.0	0.0
EMU12	6134.0	6134.0	0.0	0.0	0.0	0.0
EMU2	6487.0	6487.0	0.0	0.0	0.0	0.0
EMU3	11274.0	11274.0	0.0	0.0	0.0	0.0
EMU4	9079.0	9079.0	0.0	0.0	0.0	0.0
EMU5	6413.0	6413.0	0.0	0.0	0.0	0.0
EMU6	6876.0	6876.0	0.0	0.0	0.0	0.0
EMU7	6120.0	6120.0	0.0	0.0	0.0	0.0
EMU8	6615.0	6615.0	0.0	0.0	0.0	0.0
EMU9	7982.0	7982.0	0.0	0.0	0.0	0.0
EMU-OUT	10.0	10.0	0.0	0.0	0.0	0.0
ENO#	10.0	10.0	0.0	0.0	0.0	0.0
ENO##	10.0	10.0	0.0	0.0	0.0	0.0
ENO1	1124.0	1124.0	0.0	0.0	0.0	0.0
ENO2	938.0	938.0	0.0	0.0	0.0	0.0
ENO3	680.0	680.0	0.0	0.0	0.0	0.0
ENO4	501.0	501.0	0.0	0.0	0.0	0.0
ENO5	1560.0	1560.0	0.0	0.0	0.0	0.0
ENO6	810.0	810.0	0.0	0.0	0.0	0.0
ENO7	721.0	721.0	0.0	0.0	0.0	0.0
ENO8	431.0	431.0	0.0	0.0	0.0	0.0
ENO9	1438.0	1438.0	0.0	0.0	0.0	0.0
ENO-OUT	10.0	10.0	0.0	0.0	0.0	0.0
GAT#	10.0	10.0	0.0	0.0	0.0	0.0
GAT1	6983.0	6983.0	0.0	0.0	0.0	0.0
GAT10	6918.0	6918.0	0.0	0.0	0.0	0.0
GAT2	10308.0	10308.0	0.0	0.0	0.0	0.0
GAT3	7057.0	7057.0	0.0	0.0	0.0	0.0
GAT4	2909.0	2909.0	0.0	0.0	0.0	0.0
GAT5	7885.0	7885.0	0.0	0.0	0.0	0.0
GAT6	9254.0	9254.0	0.0	0.0	0.0	0.0
GAT7	9353.0	9353.0	0.0	0.0	0.0	0.0
GAT8	6114.0	6114.0	0.0	0.0	0.0	0.0
GAT9	3749.0	3749.0	0.0	0.0	0.0	0.0
GAT-OUT	10.0	10.0	0.0	0.0	0.0	0.0
GRE+	10.0	10.0	0.0	0.0	0.0	0.0
GRE1	7178.0	7178.0	0.0	0.0	0.0	0.0

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

Link Label	Pervious Area			Impervious Area		
	Exist (Ha)	Ultimate (Ha)	Difference (Ha)	Exist (Ha)	Ultimate (Ha)	Difference (Ha)
GRE10	5700.0	5700.0	0.0	0.0	0.0	0.0
GRE11	7929.0	7929.0	0.0	0.0	0.0	0.0
GRE12	6115.0	6115.0	0.0	0.0	0.0	0.0
GRE13	4433.0	4433.0	0.0	0.0	0.0	0.0
GRE14	3846.0	3846.0	0.0	0.0	0.0	0.0
GRE15	3877.0	3877.0	0.0	0.0	0.0	0.0
GRE16	4670.0	4670.0	0.0	0.0	0.0	0.0
GRE17	4026.0	4026.0	0.0	0.0	0.0	0.0
GRE18	3424.0	3424.0	0.0	0.0	0.0	0.0
GRE2	4577.0	4577.0	0.0	0.0	0.0	0.0
GRE3	8952.0	8952.0	0.0	0.0	0.0	0.0
GRE4	3834.0	3834.0	0.0	0.0	0.0	0.0
GRE5	6123.0	6123.0	0.0	0.0	0.0	0.0
GRE6	4291.0	4291.0	0.0	0.0	0.0	0.0
GRE7	4076.0	4076.0	0.0	0.0	0.0	0.0
GRE8	6626.0	6626.0	0.0	0.0	0.0	0.0
GRE9	7586.0	7586.0	0.0	0.0	0.0	0.0
GRE-OUT	10.0	10.0	0.0	0.0	0.0	0.0
HEL#	10.0	10.0	0.0	0.0	0.0	0.0
HEL##	10.0	10.0	0.0	0.0	0.0	0.0
HEL1	9036.0	9036.0	0.0	0.0	0.0	0.0
HEL2	8463.0	8463.0	0.0	0.0	0.0	0.0
HEL3	5967.0	5967.0	0.0	0.0	0.0	0.0
HEL4	5771.0	5771.0	0.0	0.0	0.0	0.0
HEL5	8463.0	8463.0	0.0	0.0	0.0	0.0
HEL-OUT	10.0	10.0	0.0	0.0	0.0	0.0
IP#	0.2	0.2	0.0	0.0	0.0	0.0
IP##	0.2	0.2	0.0	0.0	0.0	0.0
IP###	0.2	0.2	0.0	0.0	0.0	0.0
IP####	0.2	0.2	0.0	0.0	0.0	0.0
IP1	22.0	12.7	9.4	3.3	12.7	-9.4
IP10	345.1	328.5	16.6	8.4	25.0	-16.6
IP11	65.3	36.2	29.2	0.0	29.2	-29.2
IP12	137.1	114.1	23.0	5.0	28.0	-23.0
IP13	387.1	328.1	59.0	5.0	64.0	-59.0
IP2	31.5	29.5	2.0	10.0	12.0	-2.0
IP3	48.5	46.9	1.6	18.5	20.0	-1.6
IP4	4.6	2.4	2.2	0.2	2.4	-2.2
IP5	36.9	36.9	0.0	0.0	0.0	0.0
IP6	26.4	14.5	11.8	0.7	12.5	-11.8
IP7	33.3	25.3	8.0	3.2	11.3	-8.0
IP8	353.8	266.9	86.9	38.1	125.0	-86.9
IP9	69.4	69.4	0.0	0.6	0.6	0.0
IP-OUT	0.2	0.2	0.0	0.0	0.0	0.0
IPS#	10.0	10.0	0.0	0.0	0.0	0.0
IPS##	10.0	10.0	0.0	0.0	0.0	0.0
IPS1	0.0	0.0	0.0	0.0	0.0	0.0
IPS-OUT	10.0	10.0	0.0	0.0	0.0	0.0
JIN#	0.0	0.0	0.0	0.0	0.0	0.0
JIN##	10.0	10.0	0.0	0.0	0.0	0.0
JIN###	0.2	0.2	0.0	0.0	0.0	0.0
JIN1	5688.0	5688.0	0.0	0.0	0.0	0.0
JIN3	354.0	229.0	125.0	0.0	125.0	-125.0
JIN3A	909.0	909.0	0.0	0.0	0.0	0.0
JIN3B	804.0	699.5	104.5	11.0	115.5	-104.5
JIN3C	562.9	298.0	264.9	10.1	275.0	-264.9
JIN3CC	671.3	348.1	323.2	24.9	348.1	-323.2
JIN3D	528.0	516.0	12.0	0.0	12.0	-12.0
JIN3E	907.4	594.9	312.6	0.0	312.6	-312.6
JIN3EE	892.4	662.4	230.0	0.0	230.0	-230.0
JIN3F	0.1	0.1	0.0	0.0	0.0	0.0
JIN3FF	123.4	65.3	58.1	7.2	65.3	-58.1
JIN3G	115.8	60.1	55.7	4.4	60.1	-55.7
JIN3GG	101.8	55.8	46.1	9.7	55.8	-46.1
JIN3H	207.1	110.0	97.1	12.9	110.0	-97.1
JIN3I	48.8	26.2	22.7	3.5	26.2	-22.7
JIN3J	124.2	74.1	50.1	14.0	64.1	-50.1

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

	Pervious Area			Impervious Area		
Link Label	Exist (Ha)	Ultimate (Ha)	Difference (Ha)	Exist (Ha)	Ultimate (Ha)	Difference (Ha)
JIN3K	57.9	31.7	26.2	5.6	31.7	-26.2
JIN3L	59.7	40.1	19.6	20.5	40.1	-19.6
JIN3LL	141.5	92.0	49.5	42.5	92.0	-49.5
JIN3M	50.8	31.4	19.4	12.0	31.4	-19.4
JIN5	5950.0	5950.0	0.0	0.0	0.0	0.0
JIN6	2589.0	2531.5	57.5	0.0	57.5	-57.5
JIN6A	254.4	249.4	5.0	0.0	5.0	-5.0
JIN6B	166.1	149.6	16.5	32.7	49.2	-16.5
JIN6C	44.8	39.4	5.4	5.1	10.5	-5.4
JIN6D	25.7	19.7	6.0	10.0	16.0	-6.0
JIN6E	31.0	17.4	13.6	10.2	23.8	-13.6
JIN6EE	58.7	39.8	19.0	20.8	39.8	-19.0
JIN6F	21.4	12.8	8.6	4.2	12.8	-8.6
JIN6G	58.3	29.6	28.8	12.7	41.5	-28.8
JIN6H	39.6	9.9	29.7	1.1	30.8	-29.7
JIN6I	126.9	36.1	90.8	38.1	128.9	-90.8
JIN6J	91.9	12.3	79.6	31.1	110.7	-79.6
JIN6K	695.0	612.2	82.8	0.0	82.8	-82.8
JIN7	6773.0	6773.0	0.0	0.0	0.0	0.0
JINA	10.0	10.0	0.0	0.0	0.0	0.0
JINAA	406.1	406.1	0.0	0.0	0.0	0.0
JINAB	523.3	306.9	216.4	0.0	216.4	-216.4
JINAC	53.2	26.6	26.6	0.0	26.6	-26.6
JINACC	171.7	90.1	81.6	0.0	81.6	-81.6
JINAD	29.9	16.5	13.4	2.1	16.5	-13.4
JINADD	238.2	139.8	98.4	41.4	139.8	-98.4
JINAE	177.9	89.0	89.0	0.0	89.0	-89.0
JINAEE	270.6	135.3	135.3	0.0	135.3	-135.3
JINAF	73.3	36.7	36.7	0.0	36.7	-36.7
JINAG	255.6	127.8	127.8	0.0	127.8	-127.8
JINAH	119.7	64.5	55.3	9.2	64.5	-55.3
JINAI	147.0	73.5	73.5	0.0	73.5	-73.5
JINAJ	77.6	38.8	38.8	0.0	38.8	-38.8
JINAK	50.0	25.3	24.7	0.6	25.3	-24.7
JINAL	72.9	39.3	33.7	5.6	39.3	-33.7
JINAM	158.2	93.5	64.7	28.8	93.5	-64.7
JINAN	29.2	15.3	14.0	1.3	15.3	-14.0
JINANN	63.7	43.4	20.3	23.1	43.4	-20.3
JINAO	59.6	20.7	39.0	7.3	46.3	-39.0
JINB	485.0	354.5	130.6	0.0	130.6	-130.6
JINC	291.6	29.2	262.4	0.0	262.4	-262.4
JINCA	205.4	123.3	82.1	41.2	123.3	-82.1
JINCB	239.1	146.8	92.4	54.4	146.8	-92.4
JINCBB1	85.3	58.0	27.3	30.7	58.0	-27.3
JINCBB2	47.0	24.0	24.0	0.0	24.0	-24.0
JINCC	37.6	20.3	17.4	2.9	20.3	-17.4
JINCCC	87.5	48.4	39.1	9.3	48.4	-39.1
JINCD	53.3	31.5	21.8	9.7	31.5	-21.8
JINCDD	234.6	172.3	62.3	20.2	82.5	-62.3
JINCE	76.0	51.0	25.0	15.0	40.0	-25.0
JINCEE	74.9	63.9	11.0	6.6	17.6	-11.0
JINCF	88.2	61.0	27.2	12.8	40.0	-27.2
JINCG	74.3	30.5	43.8	2.7	46.5	-43.8
JIN-OUT	10.0	10.0	0.0	0.0	0.0	0.0
KAL#	10.0	10.0	0.0	0.0	0.0	0.0
KAL1	4086.0	4086.0	0.0	0.0	0.0	0.0
KAL2	4319.0	4319.0	0.0	0.0	0.0	0.0
KAL3	3443.0	3443.0	0.0	0.0	0.0	0.0
KAL4	5431.0	5431.0	0.0	0.0	0.0	0.0
KAL5	4718.0	4718.0	0.0	0.0	0.0	0.0
KAL6	747.0	747.0	0.0	0.0	0.0	0.0
KAL7	4261.0	4261.0	0.0	0.0	0.0	0.0
KAL8	9166.0	9166.0	0.0	0.0	0.0	0.0
KAL9	10691.0	10691.0	0.0	0.0	0.0	0.0
KAL-OUT	10.0	10.0	0.0	0.0	0.0	0.0
LIN+	10.0	10.0	0.0	0.0	0.0	0.0
LIN1	15458.0	15458.0	0.0	0.0	0.0	0.0

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

Link Label	Pervious Area Exist (Ha)	Pervious Area Ultimate (Ha)	Pervious Area Difference (Ha)	Impervious Area Exist (Ha)	Impervious Area Ultimate (Ha)	Impervious Area Difference (Ha)
LIN10	4517.0	4817.0	0.0	0.0	0.0	0.0
LIN11	2165.0	2166.0	0.0	0.0	0.0	0.0
LIN12	7645.0	7645.0	0.0	0.0	0.0	0.0
LIN13	4765.0	4765.0	0.0	0.0	0.0	0.0
LIN14	3486.0	3486.0	0.0	0.0	0.0	0.0
LIN15	4551.0	4551.0	0.0	0.0	0.0	0.0
LIN16	6230.0	5230.0	0.0	0.0	0.0	0.0
LIN17	3548.0	3548.0	0.0	0.0	0.0	0.0
LIN18	3695.0	3695.0	0.0	0.0	0.0	0.0
LIN19	4280.0	4280.0	0.0	0.0	0.0	0.0
LIN2	7667.0	7667.0	0.0	0.0	0.0	0.0
LIN3	10237.0	10237.0	0.0	0.0	0.0	0.0
LIN4	7527.0	7527.0	0.0	0.0	0.0	0.0
LIN5	2717.0	2717.0	0.0	0.0	0.0	0.0
LIN6	2725.0	2725.0	0.0	0.0	0.0	0.0
LIN7	4931.0	4931.0	0.0	0.0	0.0	0.0
LIN8	3827.0	3827.0	0.0	0.0	0.0	0.0
LIN9	6774.0	6774.0	0.0	0.0	0.0	0.0
LIN-OUT	10.0	10.0	0.0	0.0	0.0	0.0
LYO#	10.0	10.0	0.0	0.0	0.0	0.0
LYO+	10.0	10.0	0.0	0.0	0.0	0.0
LYO1	7325.0	7325.0	0.0	0.0	0.0	0.0
LYO2	4348.0	4348.0	0.0	0.0	0.0	0.0
LYO3	5613.0	5613.0	0.0	0.0	0.0	0.0
LYO4	5228.0	5228.0	0.0	0.0	0.0	0.0
LYO5	4165.0	4165.0	0.0	0.0	0.0	0.0
LYO6	10141.0	10141.0	0.0	0.0	0.0	0.0
LYO7	12218.0	12218.0	0.0	0.0	0.0	0.0
LYO9	11132.0	11132.0	0.0	0.0	0.0	0.0
LYO-OUT	10.0	10.0	0.0	0.0	0.0	0.0
MH#	0.2	0.2	0.0	0.0	0.0	0.0
MH##	0.2	0.2	0.0	0.0	0.0	0.0
MH###	0.2	0.2	0.0	0.0	0.0	0.0
MH1	201.6	150.9	50.7	23.3	74.0	-50.7
MH2	15.1	12.2	2.9	9.2	12.2	-2.9
MH3	23.4	2.3	21.0	0.0	21.0	-21.0
MH4	85.0	70.2	14.8	18.2	33.0	-14.8
MH5	3.3	1.6	1.6	0.0	1.6	-1.6
MH6	26.5	23.5	2.9	20.6	23.6	-2.9
MH7	60.0	49.7	10.2	39.5	49.7	-10.2
MH8	11.7	9.6	2.1	7.5	9.6	-2.1
MH9	92.6	51.8	40.8	10.9	51.6	-40.8
MH-OUT	0.2	0.2	0.0	0.0	0.0	0.0
MTC#	10.0	10.0	0.0	0.0	0.0	0.0
MTC##	10.0	10.0	0.0	0.0	0.0	0.0
MTC1	6112.0	6112.0	0.0	0.0	0.0	0.0
MTC2	9867.0	9867.0	0.0	0.0	0.0	0.0
MTC3	5304.0	5280.0	24.0	0.0	24.0	-24.0
MTC4	6866.0	6866.0	0.0	0.0	0.0	0.0
MTC5	227.0	227.0	0.0	0.0	0.0	0.0
MTC6	4058.0	4058.0	0.0	0.0	0.0	0.0
MTC7	3679.0	3679.0	0.0	0.0	0.0	0.0
MTC-OUT	10.0	10.0	0.0	0.0	0.0	0.0
NRM1	3115.0	3115.0	0.0	0.0	0.0	0.0
NRM2	2926.0	2926.0	0.0	0.0	0.0	0.0
NRM3	3188.0	3188.0	0.0	0.0	0.0	0.0
POG#	10.0	10.0	0.0	0.0	0.0	0.0
POG1	4185.0	4185.0	0.0	0.0	0.0	0.0
POG2	6106.0	6106.0	0.0	0.0	0.0	0.0
POG3	6104.0	6104.0	0.0	0.0	0.0	0.0
POG4	3473.0	3473.0	0.0	0.0	0.0	0.0
POG5	4246.0	4246.0	0.0	0.0	0.0	0.0
POG6	1794.0	1704.0	0.0	0.0	0.0	0.0
POG7	2284.0	2284.0	0.0	0.0	0.0	0.0
POG8	1652.0	1852.0	0.0	0.0	0.0	0.0
POG9	3369.0	3369.0	0.0	0.0	0.0	0.0
POG-OUT	10.0	10.0	0.0	0.0	0.0	0.0

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

Link Label	Pervious Area Exist (Ha)	Pervious Area Ultimate (Ha)	Pervious Area Difference (Ha)	Impervious Area Exist (Ha)	Impervious Area Ultimate (Ha)	Impervious Area Difference (Ha)
PUR1	3815.0	3815.0	0.0	0.0	0.0	0.0
PUR2	6183.0	6183.0	0.0	0.0	0.0	0.0
PUR3	6319.0	6319.0	0.0	0.0	0.0	0.0
PUR4	3288.0	3288.0	0.0	0.0	0.0	0.0
PUR5	4664.0	4623.0	41.0	0.0	41.0	-41.0
PUR-OUT	10.0	10.0	0.0	0.0	0.0	0.0
SAV#	10.0	10.0	0.0	0.0	0.0	0.0
SAV1	3156.0	3156.0	0.0	0.0	0.0	0.0
SAV10	6506.0	6506.0	0.0	0.0	0.0	0.0
SAV11	5752.0	5752.0	0.0	0.0	0.0	0.0
SAV12	3298.0	3298.0	0.0	0.0	0.0	0.0
SAV13	6230.0	6230.0	0.0	0.0	0.0	0.0
SAV2	8116.0	8116.0	0.0	0.0	0.0	0.0
SAV3	8326.0	8326.0	0.0	0.0	0.0	0.0
SAV4	6934.0	6934.0	0.0	0.0	0.0	0.0
SAV5	4784.0	4784.0	0.0	0.0	0.0	0.0
SAV6	3252.0	3252.0	0.0	0.0	0.0	0.0
SAV7	714.0	714.0	0.0	0.0	0.0	0.0
SAV8	5239.0	5239.0	0.0	0.0	0.0	0.0
SAV9	8057.0	8057.0	0.0	0.0	0.0	0.0
SAV-OUT	10.0	10.0	0.0	0.0	0.0	0.0
SC1	361.0	361.0	0.0	0.0	0.0	0.0
SC2	310.3	310.3	0.0	19.5	19.5	0.0
SC3	38.9	38.9	0.0	0.0	0.0	0.0
SC4	131.8	131.8	0.0	5.3	5.3	0.0
SC5	55.8	55.8	0.0	1.4	1.4	0.0
SC-OUT	0.2	0.2	0.0	0.0	0.0	0.0
SHO1	3672.0	3672.0	0.0	0.0	0.0	0.0
SHO2	3859.0	3859.0	0.0	0.0	0.0	0.0
SHO3	4791.0	4791.0	0.0	0.0	0.0	0.0
SHO4	4066.0	4066.0	0.0	0.0	0.0	0.0
SHO5	6592.0	6592.0	0.0	0.0	0.0	0.0
SHO6	6554.0	6554.0	0.0	0.0	0.0	0.0
SHO-OUT	10.0	10.0	0.0	0.0	0.0	0.0
SOM#	10.0	10.0	0.0	0.0	0.0	0.0
SOM##	10.0	10.0	0.0	0.0	0.0	0.0
SOM###	10.0	10.0	0.0	0.0	0.0	0.0
SOM+	10.0	10.0	0.0	0.0	0.0	0.0
SOM++	10.0	10.0	0.0	0.0	0.0	0.0
SOM+++	10.0	10.0	0.0	0.0	0.0	0.0
SOM1	2580.0	2580.0	0.0	0.0	0.0	0.0
SOM10	7285.0	7285.0	0.0	0.0	0.0	0.0
SOM11	5569.0	5569.0	0.0	0.0	0.0	0.0
SOM12	4682.0	4682.0	0.0	0.0	0.0	0.0
SOM13	2556.0	2556.0	0.0	0.0	0.0	0.0
SOM14	4459.0	4459.0	0.0	0.0	0.0	0.0
SOM15	4946.0	4946.0	0.0	0.0	0.0	0.0
SOM16	2566.0	2566.0	0.0	0.0	0.0	0.0
SOM17	2652.0	2652.0	0.0	0.0	0.0	0.0
SOM18	2976.0	2976.0	0.0	0.0	0.0	0.0
SOM19	5827.0	5827.0	0.0	0.0	0.0	0.0
SOM2	1952.0	1952.0	0.0	0.0	0.0	0.0
SOM20	5244.0	5244.0	0.0	0.0	0.0	0.0
SOM21	2434.0	2434.0	0.0	0.0	0.0	0.0
SOM22	9492.0	9492.0	0.0	0.0	0.0	0.0
SOM23	4280.0	4280.0	0.0	0.0	0.0	0.0
SOM24	5630.0	5630.0	0.0	0.0	0.0	0.0
SOM25	4367.0	4367.0	0.0	0.0	0.0	0.0
SOM26	6980.0	6980.0	0.0	0.0	0.0	0.0
SOM27	3853.0	3853.0	0.0	0.0	0.0	0.0
SOM28	3856.0	3856.0	0.0	0.0	0.0	0.0
SOM29	6583.0	6583.0	0.0	0.0	0.0	0.0
SOM3	2011.0	2011.0	0.0	0.0	0.0	0.0
SOM30	4628.0	4628.0	0.0	0.0	0.0	0.0
SOM31	4896.0	4896.0	0.0	0.0	0.0	0.0
SOM32	3828.0	3828.0	0.0	0.0	0.0	0.0
SOM4	2011.0	2011.0	0.0	0.0	0.0	0.0

335

Table H-1: Impervious and Pervious Areas for the Existing and Ultimate Development Cases

	Pervious Area			Impervious Area		
Link Label	Exist (Ha)	Ultimate (Ha)	Difference (Ha)	Exist (Ha)	Ultimate (Ha)	Difference (Ha)
SOM5	2530.0	2530.0	0.0	0.0	0.0	0.0
SOM6	3708.0	3705.0	0.0	0.0	0.0	0.0
SOM7	3592.0	3592.0	0.0	0.0	0.0	0.0
SOM8	2342.0	2342.0	0.0	0.0	0.0	0.0
SOM9	3435.0	3435.0	0.0	0.0	0.0	0.0
SCM-OUT	10.0	10.0	0.0	0.0	0.0	0.0
TEN1	9666.4	9866.4	0.0	0.0	0.0	0.0
TEN2	7510.3	7510.3	0.0	0.0	0.0	0.0
TEN3	7552.6	7652.6	0.0	0.0	0.0	0.0
TEN4	5132.1	5132.1	0.0	0.0	0.0	0.0
TEN5	6612.5	6612.5	0.0	0.0	0.0	0.0
TEN6	3834.0	3834.0	0.0	0.0	0.0	0.0
TEN7	6225.2	6225.2	0.0	0.0	0.0	0.0
TEN-OUT	10.0	10.0	0.0	0.0	0.0	0.0
WAL#	10.0	10.0	0.0	0.0	0.0	0.0
WAL##	10.0	10.0	0.0	0.0	0.0	0.0
WAL###	10.0	10.0	0.0	0.0	0.0	0.0
WAL1	4222.0	4222.0	0.0	0.0	0.0	0.0
WAL10	4192.0	4192.0	0.0	0.0	0.0	0.0
WAL11	4434.0	4434.0	0.0	0.0	0.0	0.0
WAL12	3837.0	3837.0	0.0	0.0	0.0	0.0
WAL13	3317.0	3317.0	0.0	0.0	0.0	0.0
WAL14	5610.0	5610.0	0.0	0.0	0.0	0.0
WAL15	7752.0	5457.0	2295.0	0.0	2295.0	-2295.0
WAL2	2549.0	2549.0	0.0	0.0	0.0	0.0
WAL3	2674.0	2674.0	0.0	0.0	0.0	0.0
WAL4	3114.0	3114.0	0.0	0.0	0.0	0.0
WAL5	3897.0	3897.0	0.0	0.0	0.0	0.0
WAL6	4296.0	4296.0	0.0	0.0	0.0	0.0
WAL7	4632.0	4632.0	0.0	0.0	0.0	0.0
WAL8	3127.0	3114.5	12.5	0.0	12.5	-12.5
WAL9	4916.0	4916.0	0.0	0.0	0.0	0.0
WAL-OUT	10.0	10.0	0.0	0.0	0.0	0.0
WIV#	10.0	10.0	0.0	0.0	0.0	0.0
WIV##	10.0	10.0	0.0	0.0	0.0	0.0
WIV###	10.0	10.0	0.0	0.0	0.0	0.0
WIV+	10.0	10.0	0.0	0.0	0.0	0.0
WIV1	3528.0	3528.0	0.0	0.0	0.0	0.0
WIV10	7573.0	7573.0	0.0	0.0	0.0	0.0
WIV11	5530.0	5530.0	0.0	0.0	0.0	0.0
WIV12	6217.0	6217.0	0.0	0.0	0.0	0.0
WIV13	5870.0	5870.0	0.0	0.0	0.0	0.0
WIV14	2832.0	2832.0	0.0	0.0	0.0	0.0
WIV15	2160.0	2160.0	0.0	0.0	0.0	0.0
WIV16	7120.0	7120.0	0.0	0.0	0.0	0.0
WIV17	10683.0	10683.0	0.0	0.0	0.0	0.0
WIV18	2386.0	2386.0	0.0	0.0	0.0	0.0
WIV19	1831.0	1831.0	0.0	0.0	0.0	0.0
WIV2	4522.0	4522.0	0.0	0.0	0.0	0.0
WIV20	7005.0	7005.0	0.0	0.0	0.0	0.0
WIV21	3653.0	3653.0	0.0	0.0	0.0	0.0
WIV22	2379.0	2379.0	0.0	0.0	0.0	0.0
WIV23	10.0	10.0	0.0	0.0	0.0	0.0
WIV24	3215.0	3215.0	0.0	0.0	0.0	0.0
WIV25	3708.0	3708.0	0.0	0.0	0.0	0.0
WIV26	3903.0	3903.0	0.0	0.0	0.0	0.0
WIV27	3560.0	3560.0	0.0	0.0	0.0	0.0
WIV28	12012.0	12012.0	0.0	0.0	0.0	0.0
WIV29	2035.0	2035.0	0.0	0.0	0.0	0.0
WIV3	4724.0	4724.0	0.0	0.0	0.0	0.0
WIV4	4624.0	4624.0	0.0	0.0	0.0	0.0
WIV5	10019.0	10019.0	0.0	0.0	0.0	0.0
WIV6	3022.0	3022.0	0.0	0.0	0.0	0.0
WIV7	6262.0	6262.0	0.0	0.0	0.0	0.0
WIV8	7478.0	7478.0	0.0	0.0	0.0	0.0
WIV9	4732.0	4732.0	0.0	0.0	0.0	0.0
WIV-OUT	10.0	10.0	0.0	0.0	0.0	0.0

Ipswich City Council – Works Department

Composite Mapping for 20 Year ARI Review and Recommendations

1. Background

As part of its new IPA Planning Scheme, Ipswich City Council (ICC) is preparing flood overlay mapping for 20 Year and 100 Year ARI floods.

The 100 Year ARI mapping is based on the results from recent flood studies by Sinclair Knight Merz (SKM) in respect of the urban areas of the city, and Halliburton KBR (HKBR) in respect of the rural areas.

The basis for mapping of the 20 Year ARI flood is less clear cut because:

?? In addition to estimates of 20 Year ARI flood extent by SKM for the urban areas, there is also a series of maps showing 20 Year ARI floods produced some years ago, by the then City Engineer Mr Bob Gamble, which have been used in respect of planning decisions for several years;

?? Whilst the estimated 20 Year flood levels from these map sets are generally in good agreement, there are anomalies between them of up to four metres;

?? The "Gamble" maps were produced for Ipswich City prior to its amalgamation with Moreton Shire, and do not include those parts of the former Moreton Shire now in Ipswich City;

?? A recent review of SKM's model in the Moggill to Goodna reach of the Brisbane River (Sargent 2002), has shown that there are some anomalies in the modelling of the 20 Year ARI flood which would lead to an overestimation of flood levels in this reach by up to about 2 metres;

?? Flood mapping for the rural areas has been produced by ICC from the results of hydraulic modelling undertaken by Halliburton KBR (HKBR) in 2002.

ICC's preference is to use the "Gamble" maps as the basis of the designated 20 Year flood extent as much as possible, in order to avoid inconsistencies with planning decisions and development commitments which have been based on these maps in recent years.

The purpose of this review is to determine whether this approach is supportable taking account of the issues outlined above, and to make recommendations in respect of using the various map sets to compile a composite flood overlay for the City.

2. Approach

The approach used comprised:

?? Review of the basis of the various series of maps;

?? Where possible, quantification of the likely error band associated with each map set;

?? Consideration of the degree of agreement between the various maps sets, and of anomalies between them;

?? As none of the map sets covers the whole city area, recommending the most appropriate map sets to be used in various areas to prepare a composite map for use as the 20 Year ARI flood overlay.

3. Review of Map Sets

3.1. "Gamble Maps"

The maps were produced by, or under the direction of, Mr Bob Gamble when he was City Engineer in the late 1970's/early 1980's. These have been available for many years in a series of 72 maps at 1:2,500 scale, and show the following flood designations:

?? 1974 flood

?? 1 in 20 flood (ie 20 Year ARI) flood

?? Q_{20} storm (understood to be the 20 Year ARI tributary floods).

Unfortunately, the reports describing the work done to prepare these maps are no longer available; hence it is not possible to comment on their means of derivation or their likely accuracy.

The maps show a number of river and creek cross sections used in the derivation of the flood levels, so it is apparent that considerable effort was put in to computing the flood levels. Computer modelling of flood profiles was in its early days at that time, and *state of the art* would have been steady state backwater curve modelling (such as an early version of HEC-2). It is possible that this approach or manual backwater computation would have been used.

ICC's Deputy Works Manager (Andrew Underwood) believes that the flood in 1955 was taken as indicative of 20 Year ARI conditions in deriving these maps.

The sequence of historic flood levels in the Bremer River at Ipswich (David Trumpy Bridge) is given in **Figure 1**.

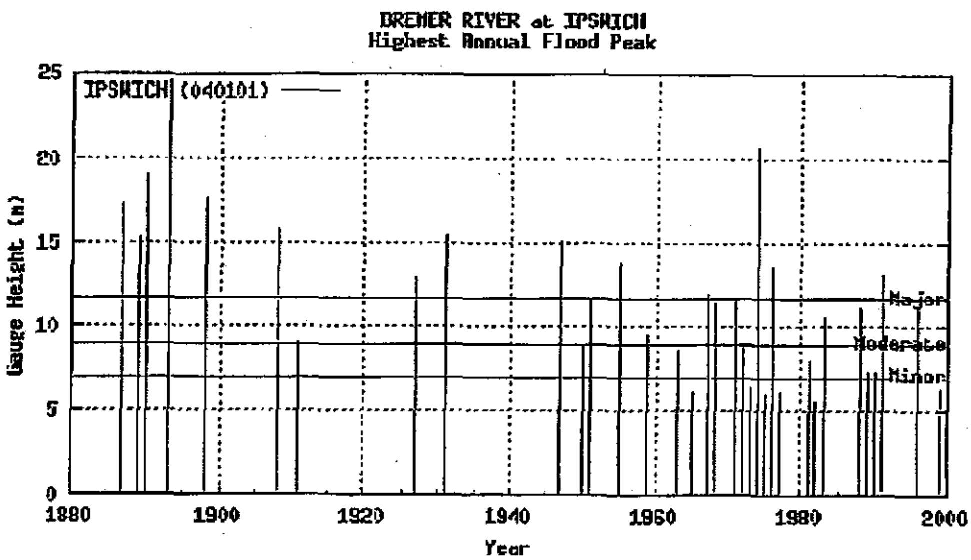


Figure 1 Highest Annual Flood Peaks – Bremer River at Ipswich (Source – Bureau of Meteorology)

Using the "Peak over threshold" approach to estimate the frequency of this event produced the curve given in **Figure 2**, which gives a frequency of about 12 Years to the 1955 event. This result is tentative, but consistent with the 1955 flood being the 10^{th} highest in this series of 115 years. Also the frequency of this flood in the Brisbane River downstream of the Bremer River confluence is not necessarily the same.

In summary, whilst the genesis of these maps cannot be determined or commented on in detail, it is clear that they have been compiled with considerable local knowledge of flood behaviour in Ipswich over a number of years. There is however, some doubt about the frequency of flood they represent.

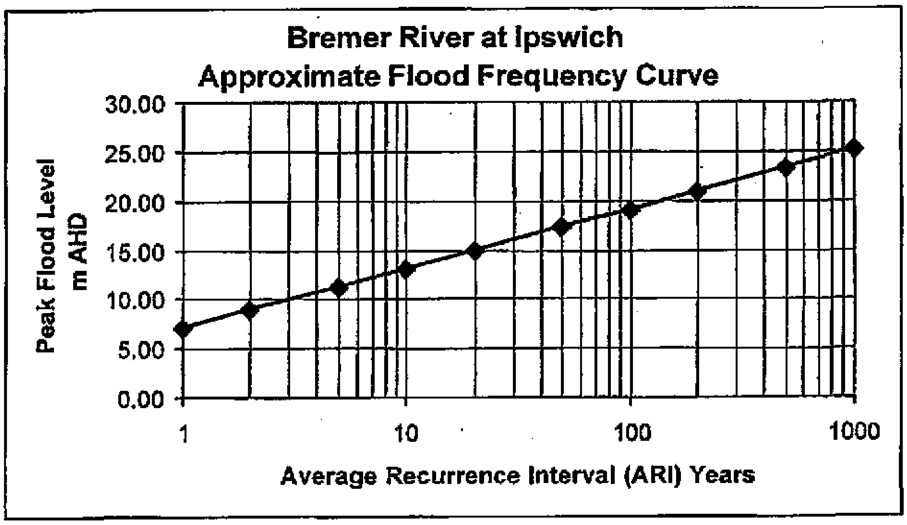


Figure 2
Approximate Flood Frequency Curve – Bremer River at Ipswich

3.2. Urban Area Maps (Sinclair Knight Merz 2000)

The urban area flood maps prepared by SKM are based on detailed hydrologic modelling (RAFTS model) and hydraulic modelling (MIKE 11 model), with the mapping of flood extent automated via GIS, whereby the intersection of the flood surface and the ground surface is mapped.

Whilst this mapping is of greater precision than that of the "Gamble" maps as a result of more sophisticated modelling techniques and improved mapping base plus the use of a digital terrain model, the recent review (Sargent 2002) has shown some anomalies in the predicted 20 Year flood levels resulting from assumptions made in both hydrologic and hydraulic modelling not being fully tested.

As shown by Sargent (2002), the maximum of this anomaly is 2.3 m at the Goodna Creek/ Brisbane River confluence, and 2.2m at the Woogaroo Creek/ Brisbane River confluence[1].

3.3. Rural Area Maps (Halliburton KBR 2002)

Halliburton KBR (HKBR 2002) extended the MIKE 11 hydraulic model upstream to include the rural parts of the Bremer/Warrill Creek catchment. Due to limitation in the base mapping for this area, it was not possible to

[1] Result from further modelling (12/2002) using MIKE 11 Version 4.1, same as design flood except for lower roughness as used for calibration for small flood events.

automate the preparation of maps of flood extent, and these maps were subsequently produced by ICC.

HKBR were also commissioned to re-model the lower Bremer River in order to resolve an anomaly in predicted flood levels at One Mile Bridge.

4. Error Bands

In discussing the performance of the MIKE 11 model in the model calibration phase, (SKM 2000, p76/77), SKM stated that acceptable calibration was based on replicating historic records to within 0.10m where continuous records were available, and 0.20m for other flood levels. In discussing the calibration for the 1974 event (the principal calibration event), SKM stated that this was achieved in the main but with some exceptions.

Then, in discussing the accuracy of the final flood mapping, SKM (2000, page 135) stated:

> *"A summary of the accuracy of different aspect of the flood modelling and mapping is"*
>
> - *Predicted flood levels ± 0.2 m*
> - *Predicted horizontal extent of inundation – up to + 10m from the location shown*
> - *Predicted depth of inundation ±½ the topographic contour interval ±0.2 m"*

There are a number of points to be made in respect of the latter statement:

?? The hydraulic model will perform best for the floods for which it has been calibrated. In this case, the differences between modelled and observed flood levels, mostly within ± 0.2 m, result from errors in both the model's replication of flood behaviour, inaccuracies in observation due, for example, by some of these being surveyed after the event from debris marks, and the effect of super-elevation at bends, which is not modelled in MIKE 11.

?? To state that model accuracy for design floods is the same as for calibration is, in my view, overoptimistic. In a calibration event the flood levels are known within ± 0.2m, and the flows are known reasonably accurately (say ± 10%).

?? However, design floods flows are subject to uncertainties resulting from the hydrologic modelling process, and flood level estimation is subject to uncertainties resulting from the assumptions regarding hydraulic roughness and boundary conditions in the hydraulic model. The review by Sargent(2002) has shown that both the hydrologic and hydraulic models are subject to considerable uncertainty in this case, and that the hydraulic roughness assumption alone could result in anomalies of up to +2.2m for the 20 Year ARI event. Taking account of the uncertainties identified in respect of design flows, could increase this substantially up to say, +3m for the 20 Year ARI event. The impact of these uncertainties was not tested by SKM.

?? Mapping errors are typically ± ½ contour interval; in the urban area the contour interval is 0.5m, hence this represents a possible error of ± 0.25 m. This in turn represents a horizontal error depending on the ground slope. However, the main source of discrepancy in this instance is between the estimated flood levels, so this error is of less concern as long as the same base mapping is used throughout.

?? It is not possible to quantify the likely error bands associated with the "Gamble" maps, but they will be subject to the same types of error as outlined above.

5. Comparison of Flood Levels and Flood Extents

The main comparison is between the 20 Year ARI flood levels and flood extents in the SKM maps and the "Gamble" maps. These are discussed on a reach basis in the following paragraphs.

5.1. Brisbane River Downstream of Bremer River Confluence

5.1.1. Woogaroo Creek confluence with the Brisbane River (Goodna)

There is a significant anomaly between the SKM and Gamble maps in this location, with the former giving a 20 Year ARI flood level of 12.0 m and the latter 10.0 m. This results in significant differences in flood extents, particularly in the Woogaroo Street/ Brisbane Terrace area, and also in the area south of Mill Street.

The review undertaken by Sargent (2002) has shown that SKM's flood levels could be overestimated by 2m in this area due to roughness uncertainties alone, and more if uncertainties in flood flow are taken into account.
As a result of Sargent's review and from the discussion in **Section 4** hereof, the "Gamble maps" are considered to be within the error band of the SKM maps, but are less conservative. However, as the Gamble maps have been

used as the basis for flood related planning decisions in this area for many years, it is justifiable to continue their use in this area.

5.1.2. Goodna Creek confluence with the Brisbane River

There is a similar anomaly at the Goodna Creek confluence, but it is smaller than that at Woogaroo Creek. In this case the SKM and Gamble maps are based on 20 Year ARI flood levels of 12.47 m and 11.0 m respectively. The resulting differences in flood extents along Goodna Creek are not large. Adjacent to Namatjira Drive, the Gamble flood extents are slightly greater than that from the SKM maps, probably due to improvement in the map base.

The review undertaken by Sargent (2002) has shown that SKM's flood levels could be overestimated by 2.4m in this area due to roughness uncertainties alone, and more if uncertainties in flood flow are taken into account. As a result of Sargent's review and from the discussion in **Section 5** hereof, the "Gamble maps" are considered to be within the error band of the SKM maps, but are less conservative. However, as the Gamble maps have been used as the basis for flood related planning decisions in this area for many years, it is justifiable to continue their use in this area.

5.1.3. Brisbane River - Goodna Creek confluence to Bremer River Confluence

The SKM and Gamble flood maps are in good agreement along this reach, with 20 Year ARI flood levels of 13.5 m and 13.3 m respectively. Again, it is justifiable to continue to use the Gamble maps in this area.

5.2. Brisbane River Upstream of Bremer River Confluence

In the reach of the Brisbane River upstream of the Bremer River confluence, the only maps available are those produced by SKM. As the 20 Year flood level at the Bremer River confluence agrees within 0.2m of Gamble's level at this point, and as the 20 year flow is essentially contained within the river banks, this level of agreement is reasonable.

The SKM maps are suitable for use in this reach.

5.3. Lower Bremer River – Ipswich City Centre to Brisbane River

The SKM and Gamble flood maps have 20 Year ARI flood levels of 13.5 m and 13.3 m respectively at the Brisbane River confluence and 15.08 m and 13.5 m respectively at the David Trumpy Bridge. Despite these differences, the flood extents are in good agreement along this reach as the flood levels are within the steep channel banks.

A review of the Bremer River MIKE 11 model by Halliburton KBR (2002b) found that there were some cross-sections of inadequate width and some roughness anomalies, which resulted in a lowering of the estimated 20 Year

ARI flood level at One Mile Bridge, of 0.94m compared to SKM's estimate. Conversely, their results gave an increased flood level at the David Trumpy Bridge of 15.36 m compared to SKM's 15.08 m.

Again, given the uncertainties inherent in the modelling and hence, in both sets of flood maps, and as the Gamble maps have been used as the basis for flood related planning decisions in this area for many years, it is justifiable to continue their use in this reach.

The Gamble maps in this area only cover the south bank of the Bremer River from its confluence with Brisbane River to Sandy Creek. The north bank of this reach of the Bremer River and that of Sandy Creek were not mapped as they were outside the local authority boundary at that time. The Gamble maps can continue to be used in this area, but flood extents on the north bank will need to be mapped by translating the equivalent flood levels from the south bank.

5.4. Upper Bremer River –Ipswich City Centre to Warrill Creek

In the Bremer River reach upstream of the city centre and up to the Warrill Creek confluence, there is increasing disparity between the SKM flood levels and those on the Gamble maps.

The HKBR review of the Bremer River MIKE 11 resulted in a lowering of the estimated 20 Year ARI flood level at One Mile Bridge, of 0.94m compared to SKM's estimate, accounting for some of the anomaly.

Despite these differences, the flood extents are in reasonable agreement along this reach of the Bremer River itself, as the flood levels are within the steep channel banks. However, there is substantial difference in flood extent along the tributaries, particularly along Mihi and Ironpot Creeks. Much of this difference is within the creek reserve and adjacent recreation reserves, but some allotments are affects

A summary of the flood level discrepencies at various locations are given in **Table 1.**

It can be seen from **Table 1** that the differences between the Gamble 20 Year ARI flood levels and those resulting from the SKM/Halliburton KBR studies range from about 1.6m at the David Trumpy Bridge to about 4m at One Mile Bridge, then reduce again to 1.1m at the Warrill Creek confluence.

Table 1
Flood Level Comparison Bremer River – City Centre to Warrill Creek

Location along Bremer River	20 Year ARI Flood Level Estimate m AHD		
	Gamble Flood Maps	SKM (2000)	Halliburton (2002)
David Trumpy Bridge	13.5	15.08	15.36
Mihi Creek confluence	13.5	16.86	16.57
Hancock Bridge Downstream Side Upstream Side	 13.5 14.0	 18.21 18.43	 17.39 17.60
Ironpot Creek confluence	14.0	18.66	17.90
Saddlier's Crossing Bridge Downstream Side Upstream Side	 15.5 16.0	 19.54 19.61	 18.71 18.77
One Mile Bridge	16.0	20.72	19.80
Warrill Ck confluence	21.0	23.81	22.10

The reasons for this are not clear. Unlike the Bremer River downstream of the City Centre, this reach is not affected by backwater from the Brisbane River. It is possible that the Gamble analysis was based primarily on floods in which Brisbane River backwater was an important factor.

In any event, these discrepancies are outside the likely error band, which Sargent's review found to be 2.2m to 2.4m in this reach due to roughness uncertainties alone, more if uncertainties in flood flow are taken into account.

ICC has proposed that the flood levels at key points given in **Table 2** be adopted, with levels in between being interpolated according to stream length. These key levels are the average of the "Gamble" and HKBR levels at these locations. Whilst simplistic, this approach is reasonable as an interim measure until further detail studies are undertaken to resolve these anomalies.

Table 2
Recommended 20 Year ARI Flood Levels
Bremer River – City Centre to Warrill Creek

Location along Bremer River	Recommended 20 Year ARI Flood Level m AHD
David Trumpy Bridge	13.5
Mihi Creek confluence	15.0
Hancock Bridge Downstream Side Upstream Side	 15.5 15.7
Ironpot Creek confluence	16.0
Saddler's Crossing Bridge Downstream Side Upstream Side	 17.1 17.4
One Mile Bridge	17.9
Warrill Ck confluence	21.0

5.5. Upstream of Bremer River/ Warrill Creek Confluence

The only estimated flood levels in the area upstream of the Bremer River/ Warrill Creek junction to the City boundary are those produced by HKBR (2002a). These levels should be used to produce 20 Year ARI flood maps in this area.

6. Discussion

From the information presented and discussed above, it can be seen that whilst there is a good level of agreement between the "Gamble" flood maps, and those prepared by SKM (and subsequently adjusted by HKBR) over many reaches, there are some reaches where substantial differences occur.

There are issues here in relation to both flood flow estimates and flood level estimates.

In respect of the Gamble flood levels and maps, the genesis of these is not known, as although the maps exist, the accompanying reports are no longer available, hence the methods of computation of both flood flows and flood levels are unclear. These maps have been used as the basis for flood related planning decisions for many years.

The SKM maps, on the other hand, are the product of a detailed study involving computer modelling of both flows throughout the catchment (using the hydrologic model RAFTS) and of flood levels along the rivers and tributaries (using a one-dimensional hydrodynamic model MIKE 11) together with the use of a digital terrain model to map the intersection of the flood and ground surfaces. The latter should be expected then to be more accurate than the Gamble maps.

These maps are certainly more precise due to the improvement in technique, but this does not translate, necessarily, into improved accuracy. As stated by Sargent (2000), in his recent review for ICC of the Brisbane/Bremer MIKE 11 model, there are a number of uncertainties in respect of modelling of the design flows which were not tested, all of which pointed to the 20 Year ARI floods being overestimated. Model runs undertaken for that review, showed that this overestimation could be as much as 2 metres in many reaches, due to uncertainties in modelled hydraulic roughness alone, greater if the uncertainty in flow estimated were to be taken into account.

The good degree of agreement between the two map sets over much of the area, suggests that the events being modelled are similar in magnitude. This is complicated, however, by the SKM model representing current (ie Post Wivenhoe Dam construction conditions) whereas the Gamble maps were produced pre- Wivenhoe Dam.

Given the error band associated with the SKM maps is now thought to be from -0.2 m (ie lower than actual) to +2.2m (higher than actual), discrepancies between the SKM maps and the Gamble maps within this range does not mean they are fundamentally different.

This level of uncertainty in the SKM maps (and that they almost certainly overestimate the 20 Year ARI flood levels generally), together with the use of the Gamble maps over many years, for flood related planning decisions, enables me to support the continued use of the latter where discrepancies are up to +2.2m.

This applies to the Bremer River below the David Trumpy Bridge and the Brisbane River below the Bremer River confluence.

In the Bremer River upstream of the David Trumpy Bridge to the Warrill Creek confluence, the discrepancies are too high (up to 4 metres) to support this position, and the proposal by ICC to adopt a practical compromise is endorsed.

I recommend that Council considers use of a description for the flood overlay prepared using this map composite which does not refer to the 20 Year ARI flood specifically. This could be, for example, the **20 Year Development Line** or **Lower Defined Flood Event.** If the latter format were adopted, the 100 Year ARI flood extent would become the **Upper Defined Flood Event.**

This approach accommodates the composite nature of the mapping, and its derivation from disparate sources; inconsistencies due to pre-dam and post-dam conditions; and ongoing changes to flood frequency relationships due to climatic changes (eg Greenhouse effect).

The latter terminology is consistent with that contained in the **Draft State Planning Policy (SPP) for Natural Disaster Mitigation** (DES 2002), which defines the Defined Flood Event as "*the flood event adopted by a local government for the management of development in a particular locality*".

If adopted, the SPP will require designation of **Natural Hazard Management Areas (Flood)**, with which the proposed overlays would be consistent.

I also recommend that the flood overlays (both 20 Year and 100 Year) contain disclaimers regarding the map accuracy. This could take the following form, for example.

DISCLAIMER

This flood overlay has been produced for the purpose of determining those properties which will be subject to planning control in relation to flood impacts.

It has been produced from a variety of sources, and represents the best available information.

Nonetheless, the information contained herein is subject to uncertainties and inaccuracies, and should not be relied upon to indicate the flood level at a particular property.

Also, the flood extent shown is a representation of the estimated flood level on current topographic maps. Actual location of given levels on the ground can be determined only by land survey.

7. Summary of Recommendations for Composite Map

The recommendations contained herein are summarised in **Table 3.**

Table 3
Recommended Map Sources for
Composite 20 Year ARI Flood Overlay

Location	Recommended Map Source
Brisbane River Downstream of Bremer River Confluence	"Gamble" Flood Maps
Brisbane River Upstream of Bremer River Confluence	SKM Flood Maps
Lower Bremer River – Ipswich City Centre to Brisbane River Confluence	"Gamble" Flood Maps with extension to north Bank of Bremer River and Sandy Creek
Ipswich City Centre to Warrill Creek Confluence	New mapping based on flood levels at key points as given in **Table 2** hereof
Upstream of Bremer River/ Warrill Creek Confluence	New mapping based on flood modelling by Halliburton KBR

8. References

DEPARTMENT OF EMERGENCY SERVICES (2002) *Draft State Planning Policy for Natural Disaster Mitigation*

HALLIBURTON KBR (2002a) *Ipswich River Flood Studies Phase 3* prepared for Ipswich City Council

HALLIBURTON KBR (2002b) *Ipswich River Flood Studies – Lower Bremer River Flooding* prepared for Ipswich City Council

SARGENT D M (2002) *Brief Review of Flood Frequency Analysis and Discharge Rating Curve for Brisbane River at Moggill Gauge* prepared for Ipswich City Council

SINCLAIR KNIGHT MERZ (2000) *Ipswich River Flood Studies Phases 1 and 2* prepared for Ipswich City Council

David Sargent MSc, BSc(Eng), DIC, MIEAust, RPEQ, CPEng
17th December 2002

IPSWICH RIVERS FLOOD STUDIES

Lower Bremer River Flooding Report

Prepared for:

IPSWICH CITY COUNCIL
PO Box 191
IPSWICH QLD 4305

Prepared by:

Halliburton KBR Pty Ltd
ABN 91 007 660 317
555 Coronation Drive, TOOWONG QLD 4066
Telephone 07 3721 6555, Facsimile 07 3721 6500

8 May 2002

BWA018-W-DO-014 Rev A

Lower Bremer River Flooding Report

1 Introduction

In November 2001, Ipswich City Council (ICC) engaged Halliburton KBR to review the existing hydraulic study of the lower Bremer River undertaken in the Ipswich Rivers Flood Study Phase 1 and 2. This work was carried out by Sinclair Knight Merz (SKM). The project also required Halliburton KBR to provide additional hydraulic analysis to assist in solving the problems of the design flood level to be adopted in this area.

Previous discussions with ICC have indicated that the design flood levels currently available from the Phases 1 and 2 report seem to be higher than experience would indicate. In particular there is concern about the calculated level of immunity at One Mile Bridge exceeding that indicated by historical evidence.

An initial review of the hydraulic model for the lower Bremer River area has revealed that the model parameters in this reach seem to contribute to the apparently high design flood levels. In addition, some of the cross-sections used in the hydraulic modelling do not extend sufficiently far enough to represent the total storage of the study site.

This report has been prepared to discuss the impacts of adjusting the MIKE11 model parameters to more realistic values and extending the necessary cross-sections hence ensuring consistency with the MIKE11 model used in the Phase 3 study.

It is noted that the version of MIKE11 adopted in this report is the same as that used in the original work. Updating to the latest version has been discussed in a previous report.

2 Review of Phase 1 and 2 Study MIKE11 hydraulic parameters

Manning's n roughness

The design philosophy used by SKM in determining the hydraulic parameters for the calibration process are summarised below:

- Two sets of Manning's n data were derived in order to achieve a good calibration. One set of Manning's n values was used in the calibration of the 1974 event, the other set being used for the 1983, 1989 and 1996 historical events.
- Manning's n values were adjusted to accommodate meanders and river bends.
- For each of model cross-section, varying model roughness values were assigned to accommodate for the both floodplain and channel roughness. A 30% increase between floodplain and channel roughness was adopted in the calibration along a majority of the Bremer River reach. However, between Chainages BREM 1000000 and BREM 1004500, the roughness of the channel is higher than that of the flood plain.
- The Manning's n channel roughness values used for the 1974 historical flood vary between 0.05 and 0.17, whereas the floodplain resistance values used vary from 0.065 to 0.19.

Following a review of the MIKE11 model, the following changes have been made to the MIKE11 model parameters derived for the 1974 historical flood event.

- Each model cross-section for the Bremer River has not been assigned varying channel and floodplain resistance values. The channel roughness has been applied across the entire cross-section.
- The upper limit of Manning's n channel roughness has been set at 0.08. This maximum value is believed to be a more realistic value.
- Where the existing channel roughness does not exceed 0.08, the applied roughness value has been unaltered.

Calculation of hydraulic radius

The MIKE11 model used in the Phases 1 and 2 study was developed using Resistance Radius (R_o) in determining the conveyance of each cross-section. However, for this analysis, Halliburton KBR have used the *Total Area, Hydraulic Radius* procedure as it is considered more appropriate for deep cross-sections such as the Bremer River.

In general, the conveyance value calculated in the previous study has been overestimated using the Resistance Radius procedure. The adoption of the new procedure for calculating hydraulic radius has increased water levels in some locations despite the significant reductions in Manning's n roughness. The effect of adjusting the hydraulic radius can be seen for the smaller ARI events downstream of Chainage BREM 1011320.

3 Extensions to model cross-sections

Along the Bremer River reach (i.e. BREM 1000000 to BREM 1028490), there are a total of 76 cross-sections in the existing MIKE11 model. Of these, approximately 70% of these sections required extending to either the left or right overbank to fully contain the flood levels. The original cross-sections used in the Phases 1 and 2 study were left unchanged and have been supplemented with ground details from the DEM provided by ICC. Where possible, the cross-sections have been extended to an elevation of 40 m AHD. Where it has not been possible to achieve this, the dedication of additional storage to cross-sections has been undertaken.

It should be noted, there has been no modification to either weir or culvert structures (including bridges) along Bremer River.

4 Comparison of results

After modifying the original MIKE11 model cross-sections and roughness parameters discussed above, the hydraulic modelling was again carried out for a range of critical floods. Floods analysed included the 2, 5, 10, 20, 50, 100, 200, and 500 year ARI and PMP events for both 18 hour and 30 hour duration storms. From the previous Phases 1 and 2 study, it was found that both these two durations produce critical levels along different reaches along the Bremer River. The 30 hour (BNE) storm event produces critical levels due to backwater effects from the Brisbane River whereas the 18 hour (BREM) duration causes peak levels from localised tributary flooding. In the area covered by this study, the BNE event is generally critical.

Tables A.1, A.2 and A.3 contain peak flows, water elevations and velocities respectively for the Bremer River. For each cross-section contained in these tables, the critical storm duration is also presented. The critical duration is expressed in terms of BNE (30 hour duration) or BREM (18 hour duration).

Also presented is Table A.4, which is a comparison of peak water levels calculated from the current analysis and those presented in the previous study. From Table A.4 it can be seen that there are significant changes (reductions) in the peak water elevations particularly in the upper end of the Bremer River.

At BREM 1000000, the most upstream Bremer River cross-section, reductions in peak elevations from 1.05m in the 2 year ARI event and up to 5.23 m in the PMP event have occurred. These reductions have resulted primarily from the reduction in Manning's n roughness, although in the PMP event the widening cross-sections would cause the significant reduction in peak water elevations.

The reductions in peak water levels between the two sets of results reduce gradually further along the Bremer River (i.e. between BREM 1000000 and 1011320) due to the smaller changes to the original model setup. Notwithstanding, in the larger events, reductions along the Bremer River have been obtained between BREM 1000000 and BREM 1028490.

In general terms, downstream of BREM 1011320, the peak water elevations produced in the smaller ARI events are greater than those calculated previously. This is due to the cross-sections and roughness parameters in this area requiring little alteration. The increases in water elevation in this location are caused from the re-calculation of conveyance using the Hydraulic Radius approach (refer Section 2).

It should be noted that despite the changes to the MIKE11 model, the extent of the two critical storm durations have not changed.

Further to the Appendix Tables, Table 1 is a summary of peak water elevations at One Mile Bridge for both the existing and previous hydraulic investigation for the full range of design events. From this table, it can be seen that the changes to the model have resulted in peak water level reductions of in the order of 1 m. However, for the PMP event, the modelling has produced a change in level in excess of 4 m.

Table 1 **Comparison of peak water elevations at One Mile Bridge (BREM 1004600) mAHD**

ARI	Current analysis	Phase 1 and 2 Study	Difference (m)
2	11.45	11.78	-0.33
5	15.03	15.56	-0.53
10	17.09	17.97	-0.87
20	19.79	20.72	-0.94
50	21.91	22.88	-0.97
100	23.52	24.47	-0.95
200	24.53	25.55	-1.02
500	26.16	27.51	-1.35
2000	35.76	39.79	-4.03

Note: The deck level of One Mile Bridge (BREM 1004600) is at approximately 14.00 m AHD

The reduction in water levels at the One Mile Bridge produced by these changes is less than was expected, and these results do not indicate a significant change in the flood immunity at the bridge compared with the Phases 1 and 2 study. It is possible that there is an additional effect produced from the Brisbane River flood levels. After the design floods for the Brisbane River have been modified with the FORGE rainfall analysis, this issue could be re-considered.

5 Conclusions

The Bremer River branch of the MIKE11 model used in the Phases 1 and 2 study has been modified in an attempt to provide consistency between the present and previous studies. Reductions in Manning's n roughness, extensions to model cross-sections and re-calculation of channel conveyance has been addressed in the analysis.

The changes made to the model have generally altered previous model results by up to 1m for events less than 100 year ARI. For the PMP event, water levels reduced by in excess of 5 m.

Appendix A

MODEL RESULTS

Table A.1 Bremer River model results—Peak water flows (m³/s)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1000350	488.7	BNE	1002.5	BNE	1563.3	BNE	2317.7	BNE	3065.1	BNE	3998.4	BREM	4096.4	BREM	5052.7	BREM	15766.7	BREM
BREM	1000910	487.8	BNE	1001.4	BNE	1559.8	BNE	2312.6	BNE	3054.3	BNE	3968.1	BREM	4087.3	BREM	5043.5	BREM	15747.9	BREM
BREM	1001410	486.7	BNE	999.9	BNE	1555.4	BNE	2306.5	BNE	3045.9	BNE	3945.3	BREM	4080.4	BREM	5036.8	BREM	15733.0	BREM
BREM	1002000	486.2	BNE	999.2	BNE	1553.3	BNE	2302.6	BNE	3039.7	BNE	3932.4	BREM	4076.9	BREM	5033.5	BREM	15720.2	BREM
BREM	1002500	485.6	BNE	998.2	BNE	1550.2	BNE	2298.0	BNE	3031.5	BNE	3913.1	BREM	4080.8	BREM	5040.1	BREM	15746.7	BREM
BREM	1002915	485.1	BNE	997.6	BNE	1548.5	BNE	2296.0	BNE	3028.7	BNE	3906.2	BREM	4078.5	BREM	5038.1	BREM	15741.9	BREM
BREM	1003165	484.6	BNE	997.2	BNE	1547.2	BNE	2294.4	BNE	3026.3	BNE	3897.3	BREM	3968.0	BREM	4537.1	BREM	13038.3	BREM
BREM	1003450	484.1	BNE	996.7	BNE	1545.7	BNE	2292.6	BNE	3023.5	BNE	3889.6	BREM	3963.0	BREM	4534.2	BREM	13034.7	BREM
BREM	1003770	483.4	BNE	994.8	BNE	1540.1	BNE	2287.5	BNE	3016.7	BNE	3874.3	BREM	3955.6	BREM	4530.1	BREM	13025.9	BREM
BREM	1003995	481.1	BNE	993.0	BNE	1535.4	BNE	2271.0	BNE	2723.1	BNE	3272.0	BREM	3294.0	BREM	3850.4	BREM	11195.4	BREM
BREM	1004235	480.4	BNE	992.1	BNE	1532.9	BNE	2265.9	BNE	2712.1	BNE	3246.0	BREM	3287.6	BREM	3844.9	BREM	11187.2	BREM
BREM	1004455	479.6	BNE	990.0	BNE	1475.2	BNE	1711.2	BNE	1951.4	BNE	2318.4	BREM	2406.4	BREM	2814.3	BREM	7108.2	BREM
BREM	1004600	479.4	BNE	989.6	BNE	1471.8	BNE	1709.0	BNE	1946.6	BNE	2309.3	BREM	2403.8	BREM	2811.5	BREM	7101.6	BREM
BREM	1004630	479.4	BNE	989.4	BNE	1471.1	BNE	1708.6	BNE	1945.7	BNE	2307.4	BREM	2403.3	BREM	2811.0	BREM	7099.5	BREM
BREM	1004675	482.1	BNE	989.5	BNE	1515.1	BNE	2255.8	BNE	2955.4	BNE	3713.6	BREM	4066.5	BREM	5032.1	BREM	15769.7	BREM
BREM	1004920	481.8	BNE	988.7	BNE	1512.4	BNE	2253.6	BNE	2951.1	BNE	3704.5	BREM	4063.9	BREM	5028.5	BREM	15764.3	BREM
BREM	1005440	481.0	BNE	987.7	BNE	1509.8	BNE	2251.6	BNE	2947.9	BNE	3695.8	BREM	4061.1	BREM	5024.9	BREM	15758.5	BREM
BREM	1005915	480.3	BNE	986.6	BNE	1506.8	BNE	2249.4	BNE	2944.4	BNE	3688.5	BREM	4059.3	BREM	5022.4	BREM	15754.2	BREM
BREM	1006170	479.9	BNE	985.9	BNE	1504.7	BNE	2248.0	BNE	2942.6	BNE	3684.3	BREM	4058.3	BREM	5020.8	BREM	15751.6	BREM
BREM	1006370	479.6	BNE	985.4	BNE	1503.5	BNE	2247.3	BNE	2941.7	BNE	3682.2	BREM	4057.7	BREM	5019.4	BREM	15749.7	BREM
BREM	1006500	479.4	BNE	985.2	BNE	1503.0	BNE	2247.0	BNE	2941.8	BNE	3681.3	BREM	4057.8	BREM	5018.5	BREM	15748.5	BREM
BREM	1006645	479.3	BNE	985.0	BNE	1502.5	BNE	2246.9	BNE	2941.1	BNE	3680.4	BREM	4061.4	BREM	5024.3	BREM	15772.5	BREM
BREM	1007110	478.4	BNE	983.6	BNE	1499.2	BNE	2244.5	BNE	2938.2	BNE	3675.1	BREM	4060.0	BREM	5021.3	BREM	15768.3	BREM
BREM	1007570	477.6	BNE	982.4	BNE	1495.7	BNE	2242.7	BNE	2935.7	BNE	3670.3	BREM	4058.8	BREM	5019.4	BREM	15764.7	BREM
BREM	1007850	477.2	BNE	981.9	BNE	1494.2	BNE	2241.7	BNE	2934.4	BNE	3667.3	BREM	4057.8	BREM	5017.8	BREM	15762.6	BREM
BREM	1008195	479.5	BNE	983.0	BNE	1488.3	BNE	2234.7	BNE	2917.6	BNE	3625.6	BREM	4065.7	BREM	5021.4	BREM	15802.6	BREM
BREM	1008400	479.1	BNE	982.6	BNE	1487.2	BNE	2233.4	BNE	2916.6	BNE	3623.8	BREM	4066.5	BREM	5019.9	BREM	15801.0	BREM
BREM	1008415	479.1	BNE	982.6	BNE	1487.1	BNE	2233.4	BNE	2916.5	BNE	3623.7	BREM	4066.4	BREM	5019.8	BREM	15800.9	BREM
BREM	1008540	478.9	BNE	982.3	BNE	1486.5	BNE	2233.2	BNE	2915.5	BNE	3621.8	BREM	4064.8	BREM	5017.5	BREM	15798.2	BREM

Table A.1 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1008935	478.3	BNE	981.6	BNE	1484.6	BNE	2231.9	BNE	2914.0	BNE	3619.2	BREM	4066.3	BREM	5014.2	BREM	15797.1	BREM
BREM	1009398	477.3	BNE	980.5	BNE	1481.6	BNE	2230.4	BNE	2911.1	BNE	3613.8	BREM	4065.0	BREM	5012.1	BREM	15787.5	BREM
BREM	1009630	476.8	BNE	979.9	BNE	1477.8	BNE	2199.8	BNE	2785.8	BNE	3397.6	BREM	3720.0	BREM	4409.1	BREM	13812.9	BREM
BREM	1009748	476.5	BNE	979.6	BNE	1477.0	BNE	2199.3	BNE	2784.6	BNE	3395.4	BREM	3719.1	BREM	4407.3	BREM	13811.8	BREM
BREM	1009920	476.5	BNE	977.8	BNE	1469.3	BNE	2219.8	BNE	2895.8	BNE	3586.5	BREM	4068.0	BREM	5015.5	BREM	15794.2	BREM
BREM	1010150	476.1	BNE	977.3	BNE	1468.1	BNE	2219.3	BNE	2894.8	BNE	3584.6	BREM	4067.4	BREM	5014.6	BREM	15792.6	BREM
BREM	1010490	475.4	BNE	976.2	BNE	1464.9	BNE	2217.8	BNE	2892.8	BNE	3581.0	BREM	4066.6	BREM	5012.9	BREM	15789.4	BREM
BREM	1010795	474.7	BNE	975.5	BNE	1463.2	BNE	2216.8	BNE	2891.5	BNE	3578.9	BREM	4065.9	BREM	5011.9	BREM	15787.5	BREM
BREM	1011105	474.2	BNE	974.8	BNE	1461.4	BNE	2216.0	BNE	2890.7	BNE	3577.7	BREM	4065.6	BREM	5011.3	BREM	15786.1	BREM
BREM	1011510	473.1	BNE	973.2	BNE	1458.8	BNE	2213.9	BNE	2888.5	BNE	3574.4	BREM	4075.6	BREM	5023.4	BREM	15810.4	BREM
BREM	1011745	472.6	BNE	973.7	BNE	1462.7	BNE	2213.3	BNE	2887.8	BNE	3573.1	BREM	4075.2	BREM	5022.8	BREM	15808.2	BREM
BREM	1011800	472.5	BNE	982.7	BNE	1474.0	BNE	2213.1	BNE	2887.6	BNE	3572.8	BREM	4075.1	BREM	5022.6	BREM	15807.7	BREM
BREM	1011930	472.3	BNE	974.2	BNE	1458.9	BNE	2212.7	BNE	2887.1	BNE	3572.1	BREM	4074.9	BREM	5022.3	BREM	15806.6	BREM
BREM	1012060	472.0	BNE	973.3	BNE	1457.1	BNE	2212.1	BNE	2886.5	BNE	3571.2	BREM	4074.7	BREM	5021.9	BREM	15805.4	BREM
BREM	1012135	471.8	BNE	972.8	BNE	1457.4	BNE	2211.8	BNE	2886.2	BNE	3570.7	BREM	4074.6	BREM	5021.7	BREM	15804.8	BREM
BREM	1012535	470.9	BNE	970.8	BNE	1451.1	BNE	2210.2	BNE	2883.9	BNE	3567.2	BREM	4073.5	BREM	5019.9	BREM	15799.1	BREM
BREM	1013125	468.7	BNE	967.7	BNE	1447.7	BNE	2207.5	BNE	2880.3	BNE	3561.6	BREM	4072.0	BREM	5017.3	BREM	15792.3	BREM
BREM	1013540	467.5	BNE	966.0	BNE	1444.7	BNE	2203.6	BNE	2876.5	BNE	3556.5	BREM	4070.9	BREM	5015.7	BREM	15789.1	BREM
BREM	1013960	466.1	BNE	964.1	BNE	1442.9	BNE	2199.9	BNE	2872.5	BNE	3551.2	BREM	4069.5	BREM	5013.7	BREM	15785.2	BREM
BREM	1014430	465.1	BNE	962.8	BNE	1442.1	BNE	2198.1	BNE	2870.3	BNE	3548.3	BREM	4068.7	BREM	5012.6	BREM	15782.7	BREM
BREM	1014910	464.1	BNE	961.4	BNE	1441.4	BNE	2196.5	BNE	2868.1	BNE	3545.5	BREM	4067.9	BREM	5011.0	BREM	15771.6	BREM
BREM	1015313	463.4	BNE	960.3	BNE	1440.7	BNE	2195.0	BNE	2866.5	BNE	3543.5	BREM	4067.4	BREM	5010.2	BREM	15769.2	BREM
BREM	1015578	462.1	BNE	958.2	BNE	1439.8	BNE	2193.2	BNE	2864.8	BNE	3541.5	BREM	4066.9	BREM	5009.6	BREM	11091.8	BREM
BREM	1015910	461.2	BNE	956.5	BNE	1438.8	BNE	2191.1	BNE	2862.2	BNE	3538.4	BREM	4074.2	BREM	5018.6	BREM	11111.0	BREM
BREM	1016310	459.2	BNE	953.4	BNE	1437.5	BNE	2188.3	BNE	2859.6	BNE	3535.4	BREM	4069.3	BREM	4917.9	BREM	7959.3	BREM
BREM	1016795	458.3	BNE	951.5	BNE	1436.4	BNE	2185.1	BNE	2856.1	BNE	3531.5	BREM	4068.1	BREM	4915.9	BREM	7919.6	BREM
BREM	1017415	456.8	BNE	949.5	BNE	1435.4	BNE	2182.2	BNE	2853.3	BNE	3528.3	BREM	4067.2	BREM	4914.7	BREM	7890.5	BREM
BREM	1017945	455.6	BNE	947.0	BNE	1434.4	BNE	2179.9	BNE	2851.0	BNE	3525.6	BREM	4066.4	BREM	4913.5	BREM	7855.8	BREM
BREM	1018230	455.1	BNE	945.5	BNE	1433.9	BNE	2178.6	BNE	2849.7	BNE	3523.9	BREM	4065.8	BREM	4912.8	BREM	7840.0	BREM
BREM	1018410	454.6	BNE	944.7	BNE	1433.7	BNE	2178.0	BNE	2849.0	BNE	3523.1	BREM	4069.7	BREM	5012.4	BREM	11098.2	BREM

Table A.1 . (continued)

Branch	Chainage (m)	ARI																	
		2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1018565	454.3	BNE	944.2	BNE	1433.5	BNE	2177.1	BNE	2848.0	BNE	3522.0	BREM	4069.4	BREM	5012.0	BREM	11097.4	BREM
BREM	1018695	453.9	BNE	943.5	BNE	1433.2	BNE	2176.5	BNE	2847.4	BNE	3521.2	BREM	4069.2	BREM	5011.7	BREM	15773.3	BREM
BREM	1018955	453.5	BNE	942.8	BNE	1432.8	BNE	2174.1	BNE	2844.6	BNE	3517.5	BREM	4068.1	BREM	5010.1	BREM	15770.2	BREM
BREM	1019365	452.4	BNE	941.1	BNE	1432.0	BNE	2170.0	BNE	2840.3	BNE	3512.1	BREM	4066.3	BREM	5007.8	BREM	15765.0	BREM
BREM	1019790	451.7	BNE	939.5	BNE	1431.2	BNE	2167.1	BNE	2835.3	BNE	3505.7	BREM	4063.9	BREM	5004.5	BREM	15758.0	BREM
BREM	1020150	451.2	BNE	938.2	BNE	1430.7	BNE	2165.1	BNE	2831.6	BNE	3500.9	BREM	4062.0	BREM	5002.0	BREM	15754.1	BREM
BREM	1020370	461.7	BNE	944.6	BNE	1459.7	BNE	2266.4	BNE	2890.3	BNE	3567.2	BREM	4189.3	BREM	5148.2	BREM	16237.2	BREM
BREM	1020445	461.4	BNE	944.1	BNE	1459.3	BNE	2225.6	BNE	2821.8	BNE	3446.1	BREM	4010.3	BREM	4845.2	BREM	15178.5	BREM
BREM	1020475	461.3	BNE	943.8	BNE	1459.2	BNE	2225.0	BNE	2821.2	BNE	3445.5	BREM	4010.1	BREM	4844.9	BREM	15178.3	BREM
BREM	1020710	461.2	BNE	940.2	BNE	1455.8	BNE	2248.5	BNE	2869.4	BNE	3550.0	BREM	4193.5	BREM	5150.8	BREM	16255.8	BREM
BREM	1021190	460.7	BNE	938.5	BNE	1453.2	BNE	2240.1	BNE	2860.5	BNE	3541.8	BREM	4191.0	BREM	5148.0	BREM	16252.9	BREM
BREM	1021880	460.1	BNE	937.4	BNE	1451.9	BNE	2232.2	BNE	2843.7	BNE	3527.0	BREM	4195.8	BREM	5153.8	BREM	16288.7	BREM
BREM	1022625	459.4	BNE	936.1	BNE	1448.4	BNE	2215.3	BNE	2819.7	BNE	3506.6	BREM	4189.7	BREM	5148.6	BREM	16284.2	BREM
BREM	1023220	458.9	BNE	934.8	BNE	1448.8	BNE	2201.5	BNE	2794.5	BNE	3494.7	BREM	4185.9	BREM	5145.4	BREM	16281.1	BREM
BREM	1023500	458.1	BNE	934.6	BNE	1463.6	BNE	2198.0	BNE	2789.9	BNE	3493.3	BREM	4185.5	BREM	5145.0	BREM	16280.8	BREM
BREM	1023690	458.6	BNE	934.5	BNE	1447.0	BNE	2196.0	BNE	2786.9	BNE	3492.5	BREM	4185.3	BREM	5144.7	BREM	16280.6	BREM
BREM	1024045	458.3	BNE	934.2	BNE	1445.1	BNE	2193.8	BNE	2782.9	BNE	3491.7	BREM	4185.1	BREM	5144.3	BREM	16280.3	BREM
BREM	1024370	458.1	BNE	934.0	BNE	1445.2	BNE	2192.9	BNE	2780.6	BNE	3491.4	BREM	4185.0	BREM	5144.1	BREM	16280.2	BREM
BREM	1024635	457.8	BNE	933.8	BNE	1444.7	BNE	2191.2	BNE	2777.4	BNE	3491.0	BREM	4184.9	BREM	5143.9	BREM	16280.0	BREM
BREM	1025025	457.6	BNE	933.3	BNE	1443.5	BNE	2187.6	BNE	2770.6	BNE	3490.1	BREM	4184.7	BREM	5143.5	BREM	16279.5	BREM
BREM	1025485	457.4	BNE	933.1	BNE	1442.7	BNE	2184.2	BNE	2764.5	BNE	3489.6	BREM	4184.5	BREM	5143.3	BREM	16279.4	BREM
BREM	1025795	457.3	BNE	933.0	BNE	1442.5	BNE	2183.0	BNE	2762.6	BNE	3489.5	BREM	4184.5	BREM	5143.3	BREM	16279.3	BREM
BREM	1026035	457.2	BNE	932.9	BNE	1442.3	BNE	2182.1	BNE	2761.1	BNE	3489.4	BREM	4184.5	BREM	5143.2	BREM	16279.3	BREM
BREM	1026355	457.0	BNE	932.8	BNE	1441.9	BNE	2178.9	BNE	2755.3	BNE	3489.1	BREM	4184.4	BREM	5143.2	BREM	16279.2	BREM
BREM	1026830	456.8	BNE	932.6	BNE	1441.5	BNE	2177.2	BNE	2751.3	BNE	3489.3	BREM	4196.3	BREM	5157.6	BREM	16338.9	BREM
BREM	1027370	456.7	BNE	932.3	BNE	1440.7	BNE	2169.4	BNE	2738.5	BNE	3489.1	BREM	4196.2	BREM	5157.5	BREM	16338.8	BREM
BREM	1027740	456.7	BNE	932.3	BNE	1440.6	BNE	2167.7	BNE	2735.6	BNE	3489.1	BREM	4196.2	BREM	5157.5	BREM	16338.7	BREM
BREM	1028015	456.7	BNE	932.2	BNE	1440.5	BNE	2166.9	BNE	2731.8	BNE	3489.1	BREM	4196.2	BREM	5157.5	BREM	16338.7	BREM
BREM	1028340	456.7	BNE	932.2	BNE	1440.5	BNE	2166.7	BNE	2730.3	BNE	3489.1	BREM	4196.2	BREM	5157.5	BREM	16338.7	BREM

Table A.2 Bremer River model results—Peak water elevations (m AHD)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1000000	15.29	BNE	17.86	BNE	19.71	BNE	22.10	BNE	24.29	BNE	25.66	BREM	26.31	BREM	27.61	BREM	36.81	BREM
BREM	1000700	15.00	BNE	17.40	BNE	19.20	BNE	21.62	BNE	23.73	BNE	25.15	BREM	25.97	BREM	27.40	BREM	36.74	BREM
BREM	1001120	14.60	BNE	17.18	BNE	19.03	BNE	21.49	BNE	23.54	BNE	24.97	BREM	25.83	BREM	27.30	BREM	36.68	BREM
BREM	1001700	13.93	BNE	16.81	BNE	18.70	BNE	21.22	BNE	23.28	BNE	24.71	BNE	25.62	BREM	27.10	BREM	36.54	BREM
BREM	1002300	13.27	BNE	16.28	BNE	18.23	BNE	20.81	BNE	22.92	BNE	24.46	BNE	25.42	BREM	26.93	BREM	36.39	BREM
BREM	1002700	12.81	BNE	15.89	BNE	17.84	BNE	20.47	BNE	22.59	BNE	24.18	BNE	25.17	BREM	26.71	BREM	36.12	BREM
BREM	1003130	12.39	BNE	15.53	BNE	17.45	BNE	20.07	BNE	22.16	BNE	23.74	BNE	24.72	BREM	26.32	BREM	35.83	BREM
BREM	1003130	12.39	BNE	15.53	BNE	17.45	BNE	20.07	BNE	22.16	BNE	23.74	BNE	24.72	BREM	26.32	BREM	35.83	BREM
BREM	1003200	12.34	BNE	15.49	BNE	17.41	BNE	20.02	BNE	22.11	BNE	23.69	BNE	24.68	BREM	26.28	BREM	35.82	BREM
BREM	1003700	11.65	BNE	15.19	BNE	17.21	BNE	19.89	BNE	21.98	BNE	23.57	BNE	24.57	BREM	26.19	BREM	35.78	BREM
BREM	1003840	11.64	BNE	15.17	BNE	17.21	BNE	19.89	BNE	21.98	BNE	23.57	BNE	24.57	BREM	26.19	BREM	35.78	BREM
BREM	1003840	11.64	BNE	15.17	BNE	17.21	BNE	19.89	BNE	21.98	BNE	23.57	BNE	24.57	BREM	26.19	BREM	35.78	BREM
BREM	1004150	11.61	BNE	15.14	BNE	17.17	BNE	19.83	BNE	21.95	BNE	23.55	BNE	24.55	BREM	26.18	BREM	35.77	BREM
BREM	1004320	11.58	BNE	15.13	BNE	17.16	BNE	19.82	BNE	21.93	BNE	23.54	BNE	24.55	BREM	26.17	BREM	35.77	BREM
BREM	1004320	11.58	BNE	15.13	BNE	17.16	BNE	19.82	BNE	21.93	BNE	23.54	BNE	24.55	BREM	26.17	BREM	35.77	BREM
BREM	1004590	11.45	BNE	15.03	BNE	17.09	BNE	19.79	BNE	21.91	BNE	23.52	BNE	24.53	BREM	26.16	BREM	35.76	BREM
BREM	1004610	11.41	BNE	14.71	BNE	16.95	BNE	19.72	BNE	21.86	BNE	23.47	BNE	24.48	BREM	26.11	BREM	35.65	BREM
BREM	1004650	11.37	BNE	14.65	BNE	16.93	BNE	19.71	BNE	21.85	BNE	23.47	BNE	24.48	BREM	26.11	BREM	35.65	BREM
BREM	1004650	11.37	BNE	14.65	BNE	16.93	BNE	19.71	BNE	21.85	BNE	23.47	BNE	24.48	BREM	26.11	BREM	35.65	BREM
BREM	1004700	11.32	BNE	14.59	BNE	16.90	BNE	19.69	BNE	21.83	BNE	23.45	BNE	24.47	BREM	26.10	BREM	35.64	BREM
BREM	1005140	11.07	BNE	14.23	BNE	16.66	BNE	19.46	BNE	21.56	BNE	23.22	BNE	24.25	BREM	25.93	BREM	35.52	BREM
BREM	1005740	10.87	BNE	14.00	BNE	16.43	BNE	19.20	BNE	21.23	BNE	22.88	BNE	23.91	BREM	25.64	BREM	35.22	BREM
BREM	1006090	10.68	BNE	13.83	BNE	16.29	BNE	19.06	BNE	21.08	BNE	22.74	BNE	23.78	BREM	25.53	BREM	35.09	BREM
BREM	1006250	10.61	BNE	13.76	BNE	16.23	BNE	18.99	BNE	20.99	BNE	22.64	BNE	23.67	BREM	25.43	BREM	34.99	BREM
BREM	1006490	10.40	BNE	13.56	BNE	16.03	BNE	18.77	BNE	20.74	BNE	22.34	BNE	23.32	BREM	25.04	BREM	34.75	BREM
BREM	1006510	10.37	BNE	13.52	BNE	15.99	BNE	18.71	BNE	20.67	BNE	22.27	BNE	23.24	BREM	24.92	BREM	33.57	BREM
BREM	1006780	10.06	BNE	13.34	BNE	15.88	BNE	18.62	BNE	20.60	BNE	22.18	BNE	23.12	BREM	24.71	BREM	33.44	BNE
BREM	1007440	9.23	BNE	12.78	BNE	15.47	BNE	18.28	BNE	20.28	BNE	21.88	BNE	22.80	BREM	24.37	BREM	33.42	BNE
BREM	1007700	9.05	BNE	12.58	BNE	15.30	BNE	18.10	BNE	20.10	BNE	21.69	BNE	22.60	BREM	24.18	BREM	33.41	BNE
BREM	1008000	8.88	BNE	12.41	BNE	15.14	BNE	17.90	BNE	19.89	BNE	21.46	BNE	22.32	BREM	23.93	BREM	33.41	BNE

Table A.2 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1008000	8.88	BNE	12.41	BNE	15.14	BNE	17.90	BNE	19.89	BNE	21.46	BNE	22.32	BREM	23.93	BREM	33.41	BNE
BREM	1008390	8.59	BNE	12.17	BNE	14.93	BNE	17.60	BNE	19.55	BNE	21.17	BNE	21.96	BREM	23.59	BREM	33.40	BNE
BREM	1008410	8.57	BNE	12.14	BNE	14.82	BNE	17.39	BNE	19.39	BNE	21.04	BNE	21.83	BREM	23.47	BREM	33.39	BNE
BREM	1008420	8.57	BNE	12.13	BNE	14.80	BNE	17.39	BNE	19.41	BNE	21.07	BNE	21.86	BREM	23.52	BREM	33.39	BNE
BREM	1008660	8.37	BNE	11.92	BNE	14.61	BNE	17.13	BNE	19.09	BNE	20.75	BNE	21.53	BREM	23.25	BREM	33.39	BNE
BREM	1009210	8.05	BNE	11.58	BNE	14.31	BNE	16.79	BNE	18.69	BNE	20.27	BNE	20.93	BREM	22.72	BREM	33.39	BNE
BREM	1009585	7.96	BNE	11.48	BNE	14.19	BNE	16.67	BNE	18.60	BNE	20.19	BNE	20.82	BREM	22.61	BREM	33.39	BNE
BREM	1009585	7.96	BNE	11.48	BNE	14.19	BNE	16.67	BNE	18.60	BNE	20.19	BNE	20.82	BREM	22.61	BREM	33.39	BNE
BREM	1009675	7.94	BNE	11.45	BNE	14.15	BNE	16.60	BNE	18.54	BNE	20.14	BNE	20.77	BREM	22.58	BREM	33.38	BNE
BREM	1009820	7.92	BNE	11.42	BNE	14.11	BNE	16.57	BNE	18.50	BNE	20.10	BNE	20.72	BREM	22.53	BREM	33.38	BNE
BREM	1009820	7.92	BNE	11.42	BNE	14.11	BNE	16.57	BNE	18.50	BNE	20.10	BNE	20.72	BREM	22.53	BREM	33.38	BNE
BREM	1010020	7.81	BNE	11.27	BNE	13.95	BNE	16.39	BNE	18.30	BNE	19.94	BNE	20.53	BREM	22.38	BREM	33.38	BNE
BREM	1010280	7.67	BNE	11.15	BNE	13.87	BNE	16.32	BNE	18.18	BNE	19.77	BNE	20.30	BREM	22.18	BREM	33.38	BNE
BREM	1010700	7.55	BNE	10.99	BNE	13.70	BNE	16.12	BNE	17.94	BNE	19.50	BNE	19.96	BREM	21.80	BREM	33.38	BNE
BREM	1010890	7.46	BNE	10.88	BNE	13.60	BNE	15.99	BNE	17.78	BNE	19.30	BNE	19.67	BREM	21.46	BREM	33.37	BNE
BREM	1011320	7.19	BNE	10.68	BNE	13.44	BNE	15.85	BNE	17.66	BNE	19.18	BNE	19.58	BNE	21.20	BREM	33.37	BNE
BREM	1011700	6.92	BNE	10.43	BNE	13.19	BNE	15.58	BNE	17.35	BNE	18.87	BNE	19.54	BNE	20.77	BNE	33.37	BNE
BREM	1011790	6.85	BNE	10.37	BNE	13.14	BNE	15.52	BNE	17.28	BNE	18.78	BNE	19.53	BNE	20.76	BNE	33.37	BNE
BREM	1011810	6.84	BNE	10.33	BNE	13.09	BNE	15.48	BNE	17.23	BNE	18.73	BNE	19.52	BNE	20.73	BNE	33.34	BNE
BREM	1012050	6.78	BNE	10.28	BNE	13.05	BNE	15.43	BNE	17.17	BNE	18.65	BNE	19.51	BNE	20.73	BNE	33.34	BNE
BREM	1012070	6.77	BNE	10.27	BNE	13.03	BNE	15.41	BNE	17.15	BNE	18.55	BNE	19.50	BNE	20.72	BNE	33.33	BNE
BREM	1012200	6.73	BNE	10.22	BNE	12.99	BNE	15.36	BNE	17.09	BNE	18.50	BNE	19.50	BNE	20.72	BNE	33.33	BNE
BREM	1012870	6.67	BNE	10.18	BNE	12.95	BNE	15.31	BNE	17.01	BNE	18.39	BNE	19.48	BNE	20.71	BNE	33.33	BNE
BREM	1013380	6.59	BNE	10.11	BNE	12.89	BNE	15.27	BNE	16.96	BNE	18.35	BNE	19.48	BNE	20.71	BNE	33.33	BNE
BREM	1013700	6.52	BNE	10.07	BNE	12.83	BNE	15.23	BNE	16.93	BNE	18.33	BNE	19.48	BNE	20.71	BNE	33.33	BNE
BREM	1014220	6.38	BNE	9.95	BNE	12.70	BNE	15.07	BNE	16.77	BNE	18.30	BNE	19.46	BNE	20.70	BNE	33.32	BNE
BREM	1014640	6.31	BNE	9.87	BNE	12.62	BNE	14.97	BNE	16.63	BNE	18.30	BNE	19.45	BNE	20.69	BNE	33.32	BNE
BREM	1015180	6.20	BNE	9.75	BNE	12.49	BNE	14.82	BNE	16.49	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1015445	6.21	BNE	9.77	BNE	12.52	BNE	14.86	BNE	16.54	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1015445	6.21	BNE	9.77	BNE	12.52	BNE	14.86	BNE	16.54	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE

Table A.2 (continued)

Branch	Chainage	ARI																	
	(m)	2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1015710	6.17	BNE	9.74	BNE	12.49	BNE	14.83	BNE	16.51	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1016110	6.17	BNE	9.73	BNE	12.49	BNE	14.82	BNE	16.49	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1016110	6.17	BNE	9.73	BNE	12.49	BNE	14.82	BNE	16.49	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1016510	6.14	BNE	9.68	BNE	12.44	BNE	14.77	BNE	16.45	BNE	18.30	BNE	19.44	BNE	20.69	BNE	33.32	BNE
BREM	1017080	6.07	BNE	9.60	BNE	12.34	BNE	14.65	BNE	16.37	BNE	18.30	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1017750	5.99	BNE	9.53	BNE	12.27	BNE	14.58	BNE	16.32	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1018140	5.92	BNE	9.46	BNE	12.23	BNE	14.54	BNE	16.29	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1018320	5.93	BNE	9.46	BNE	12.23	BNE	14.53	BNE	16.28	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1018320	5.93	BNE	9.46	BNE	12.23	BNE	14.53	BNE	16.28	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1018500	5.90	BNE	9.43	BNE	12.19	BNE	14.50	BNE	16.26	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.31	BNE
BREM	1018630	5.91	BNE	9.44	BNE	12.20	BNE	14.51	BNE	16.27	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.32	BNE
BREM	1018630	5.91	BNE	9.44	BNE	12.20	BNE	14.51	BNE	16.27	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.32	BNE
BREM	1018760	5.87	BNE	9.39	BNE	12.16	BNE	14.47	BNE	16.26	BNE	18.29	BNE	19.43	BNE	20.68	BNE	33.32	BNE
BREM	1019150	5.82	BNE	9.37	BNE	12.11	BNE	14.41	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.32	BNE
BREM	1019580	5.76	BNE	9.29	BNE	12.03	BNE	14.34	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.32	BNE
BREM	1020000	5.65	BNE	9.14	BNE	11.86	BNE	14.20	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020300	5.61	BNE	9.09	BNE	11.81	BNE	14.15	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020300	5.61	BNE	9.09	BNE	11.81	BNE	14.15	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020440	5.58	BNE	9.08	BNE	11.80	BNE	14.13	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020440	5.58	BNE	9.08	BNE	11.80	BNE	14.13	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020450	5.58	BNE	9.07	BNE	11.80	BNE	14.13	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020500	5.55	BNE	9.07	BNE	11.79	BNE	14.13	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020500	5.55	BNE	9.07	BNE	11.79	BNE	14.13	BNE	16.23	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1020920	5.32	BNE	8.92	BNE	11.71	BNE	14.06	BNE	16.22	BNE	18.29	BNE	19.42	BNE	20.68	BNE	33.31	BNE
BREM	1021460	5.05	BNE	8.56	BNE	11.41	BNE	13.88	BNE	16.23	BNE	18.29	BNE	19.41	BNE	20.67	BNE	33.31	BNE
BREM	1022300	4.65	BNE	8.05	BNE	10.84	BNE	13.55	BNE	16.23	BNE	18.29	BNE	19.41	BNE	20.67	BNE	33.31	BNE
BREM	1022950	4.32	BNE	7.63	BNE	10.47	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.41	BNE	20.67	BNE	33.31	BNE
BREM	1023490	4.07	BNE	7.31	BNE	10.12	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.41	BNE	20.67	BNE	33.31	BNE
BREM	1023510	4.05	BNE	7.22	BNE	10.09	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.40	BNE	20.66	BNE	33.30	BNE
BREM	1023870	3.94	BNE	7.09	BNE	9.84	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.40	BNE	20.66	BNE	33.30	BNE

Table A.2 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1024220	3.80	BNE	6.94	BNE	9.68	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.39	BNE	20.66	BNE	33.30	BNE
BREM	1024520	3.67	BNE	6.80	BNE	9.57	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.39	BNE	20.66	BNE	33.30	BNE
BREM	1024750	3.60	BNE	6.73	BNE	9.50	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.39	BNE	20.66	BNE	33.29	BNE
BREM	1025300	3.46	BNE	6.53	BNE	9.34	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.39	BNE	20.66	BNE	33.29	BNE
BREM	1025670	3.30	BNE	6.29	BNE	9.14	BNE	13.54	BNE	16.22	BNE	18.29	BNE	19.38	BNE	20.66	BNE	33.29	BNE
BREM	1025920	3.18	BNE	6.13	BNE	8.97	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.38	BNE	20.65	BNE	33.29	BNE
BREM	1026150	3.10	BNE	6.02	BNE	8.83	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.38	BNE	20.65	BNE	33.29	BNE
BREM	1026560	2.95	BNE	5.78	BNE	8.48	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.38	BNE	20.65	BNE	33.29	BNE
BREM	1027100	2.72	BNE	5.37	BNE	8.15	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.38	BNE	20.65	BNE	33.29	BNE
BREM	1027640	2.49	BNE	4.90	BNE	7.76	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.37	BNE	20.65	BNE	33.29	BNE
BREM	1027840	2.42	BNE	4.75	BNE	7.61	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.37	BNE	20.65	BNE	33.29	BNE
BREM	1028190	2.24	BNE	4.43	BNE	7.33	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.37	BNE	20.65	BNE	33.28	BNE
BREM	1028490	2.06	BNE	4.17	BNE	7.15	BNE	13.53	BNE	16.22	BNE	18.29	BNE	19.36	BNE	20.64	BNE	33.28	BNE

Table A.3 Bremer River model results—Peak water velocity (m/s)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1000000	0.55	BNE	0.86	BNE	1.03	BNE	1.10	BNE	1.16	BNE	1.17	BREM	1.15	BREM	1.18	BREM	1.21	BREM
BREM	1000350	0.80	BNE	1.00	BNE	1.12	BNE	1.19	BREM	1.25	BREM	1.29	BREM	1.24	BREM	1.27	BREM	1.39	BREM
BREM	1000700	0.73	BREM	0.84	BNE	0.85	BNE	0.94	BNE	0.96	BNE	0.99	BNE	0.97	BREM	1.01	BREM	1.14	BREM
BREM	1000910	0.86	BNE	0.96	BREM	0.93	BNE	1.08	BNE	1.08	BNE	1.11	BREM	0.92	BREM	0.95	BREM	1.09	BREM
BREM	1001120	0.79	BREM	0.75	BREM	0.75	BNE	0.75	BREM	0.74	BREM	0.71	BREM	0.76	BREM	0.77	BREM	0.78	BREM
BREM	1001410	0.92	BNE	0.98	BREM	0.95	BREM	1.06	BNE	1.06	BNE	1.09	BREM	1.04	BREM	1.07	BREM	1.17	BREM
BREM	1001700	0.98	BNE	1.16	BNE	1.27	BNE	1.35	BNE	1.41	BNE	1.48	BNE	1.46	BREM	1.51	BREM	1.68	BREM
BREM	1002000	1.04	BNE	1.17	BNE	1.21	BREM	1.30	BNE	1.35	BREM	1.37	BREM	1.35	BREM	1.39	BREM	1.52	BREM
BREM	1002300	0.76	BNE	0.89	BNE	0.89	BREM	0.96	BNE	0.98	BNE	0.99	BNE	0.97	BREM	0.99	BREM	1.06	BREM
BREM	1002500	1.04	BNE	1.20	BNE	1.25	BREM	1.33	BREM	1.41	BREM	1.43	BREM	1.40	BREM	1.45	BREM	1.59	BREM
BREM	1002700	1.03	BNE	1.22	BNE	1.36	BNE	1.46	BNE	1.57	BREM	1.64	BREM	1.63	BREM	1.70	BREM	2.01	BREM
BREM	1002915	1.00	BNE	1.22	BNE	1.41	BNE	1.53	BREM	1.72	BREM	1.76	BREM	1.71	BREM	1.77	BREM	2.13	BREM
BREM	1003130	0.86	BNE	1.08	BNE	1.27	BNE	1.39	BREM	1.56	BREM	1.61	BREM	1.56	BREM	1.61	BREM	1.94	BREM
BREM	1003130	0.86	BNE	1.08	BNE	1.27	BNE	1.39	BREM	1.56	BREM	1.61	BREM	1.56	BREM	1.61	BREM	1.94	BREM
BREM	1003165	0.88	BNE	1.08	BNE	1.26	BNE	1.38	BREM	1.55	BREM	1.59	BREM	1.54	BREM	1.60	BREM	1.93	BREM
BREM	1003200	0.90	BNE	1.08	BNE	1.25	BNE	1.37	BREM	1.54	BREM	1.58	BREM	1.53	BREM	1.59	BREM	1.91	BREM
BREM	1003450	1.21	BNE	1.31	BNE	1.42	BREM	1.58	BNE	1.61	BNE	1.66	BNE	1.39	BREM	1.40	BREM	1.67	BREM
BREM	1003700	2.04	BNE	2.27	BREM	2.15	BREM	2.83	BNE	2.88	BNE	2.93	BNE	2.31	BREM	2.37	BREM	2.98	BREM
BREM	1003770	0.32	BNE	0.36	BREM	0.40	BNE	0.45	BNE	0.51	BREM	0.55	BREM	0.53	BREM	0.57	BREM	0.72	BREM
BREM	1003840	0.17	BNE	0.19	BNE	0.27	BNE	0.34	BNE	0.38	BREM	0.44	BREM	0.43	BREM	0.45	BREM	0.62	BREM
BREM	1003840	0.17	BNE	0.19	BNE	0.27	BNE	0.34	BNE	0.37	BREM	0.38	BREM	0.38	BREM	0.39	BREM	0.54	BREM
BREM	1003995	0.27	BNE	0.30	BNE	0.40	BNE	0.45	BNE	0.50	BREM	0.52	BREM	0.51	BREM	0.52	BREM	0.60	BREM
BREM	1004150	0.82	BNE	0.84	BREM	0.87	BREM	0.96	BNE	0.96	BNE	0.96	BNE	0.88	BREM	0.88	BREM	1.01	BREM
BREM	1004235	0.56	BREM	0.59	BREM	0.56	BNE	0.62	BNE	0.61	BNE	0.63	BREM	0.59	BREM	0.60	BREM	0.66	BREM
BREM	1004320	0.44	BREM	0.46	BREM	0.45	BNE	0.46	BNE	0.46	BREM	0.47	BREM	0.47	BREM	0.47	BREM	0.49	BREM
BREM	1004320	0.44	BREM	0.46	BREM	0.45	BNE	0.46	BNE	0.46	BREM	0.47	BREM	0.47	BREM	0.47	BREM	0.49	BREM
BREM	1004455	0.64	BREM	0.65	BREM	0.64	BNE	0.65	BREM	0.64	BNE	0.65	BREM	0.66	BREM	0.67	BREM	0.68	BREM
BREM	1004590	1.20	BNE	1.34	BNE	1.35	BREM	1.33	BNE	1.37	BREM	1.37	BNE	1.42	BREM	1.43	BREM	1.44	BREM
BREM	1004600	1.60	BREM	2.18	BNE	2.62	BNE	2.68	BREM	2.81	BNE	2.93	BNE	2.88	BREM	2.92	BREM	3.01	BREM
BREM	1004610	1.22	BREM	1.36	BNE	1.36	BREM	1.35	BNE	1.38	BREM	1.39	BNE	1.44	BREM	1.44	BREM	1.46	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1004630	1.22	BREM	1.34	BNE	1.35	BREM	1.34	BNE	1.36	BREM	1.37	BNE	1.42	BREM	1.43	BREM	1.44	BREM
BREM	1004650	1.21	BREM	1.33	BNE	1.33	BREM	1.34	BNE	1.35	BREM	1.35	BNE	1.40	BREM	1.41	BREM	1.42	BREM
BREM	1004650	1.31	BNE	1.44	BREM	1.39	BREM	1.60	BNE	1.61	BNE	1.63	BNE	1.43	BREM	1.47	BREM	1.63	BREM
BREM	1004675	1.32	BNE	1.45	BREM	1.38	BNE	1.61	BNE	1.62	BNE	1.64	BREM	1.44	BREM	1.48	BREM	1.64	BREM
BREM	1004700	1.33	BNE	1.46	BREM	1.40	BNE	1.62	BNE	1.63	BNE	1.66	BREM	1.45	BREM	1.49	BREM	1.66	BREM
BREM	1004920	0.89	BNE	1.07	BNE	1.10	BREM	1.15	BNE	1.17	BNE	1.19	BREM	1.18	BREM	1.19	BREM	1.26	BREM
BREM	1005140	0.73	BNE	0.94	BNE	1.11	BNE	1.21	BNE	1.32	BREM	1.36	BREM	1.35	BREM	1.38	BREM	1.51	BREM
BREM	1005440	0.73	BNE	0.93	BNE	1.09	BNE	1.16	BNE	1.26	BREM	1.27	BREM	1.27	BREM	1.30	BREM	1.46	BREM
BREM	1005740	0.73	BNE	0.92	BNE	1.07	BNE	1.13	BREM	1.20	BREM	1.21	BREM	1.22	BREM	1.24	BREM	1.63	BREM
BREM	1005915	0.82	BNE	0.95	BNE	1.05	BNE	1.10	BREM	1.13	BREM	1.17	BNE	1.17	BREM	1.20	BREM	1.50	BREM
BREM	1006090	1.10	BNE	1.15	BREM	1.14	BNE	1.16	BREM	1.15	BREM	1.15	BREM	1.19	BREM	1.21	BREM	1.39	BREM
BREM	1006170	0.75	BNE	0.87	BNE	0.98	BNE	1.03	BREM	1.10	BREM	1.18	BREM	1.16	BREM	1.19	BREM	1.44	BREM
BREM	1006250	0.64	BNE	0.79	BNE	0.93	BNE	1.03	BNE	1.14	BREM	1.27	BREM	1.26	BREM	1.31	BREM	1.50	BREM
BREM	1006370	0.81	BNE	0.99	BNE	1.15	BNE	1.27	BNE	1.40	BREM	1.55	BREM	1.54	BREM	1.60	BREM	1.81	BREM
BREM	1006490	1.16	BNE	1.32	BNE	1.53	BNE	1.66	BNE	1.83	BREM	2.01	BREM	1.98	BREM	2.05	BREM	2.34	BREM
BREM	1006500	1.38	BNE	1.65	BNE	1.89	BNE	2.07	BNE	2.29	BREM	2.52	BREM	2.49	BREM	2.56	BREM	5.08	BREM
BREM	1006510	1.17	BNE	1.33	BNE	1.54	BNE	1.67	BNE	1.84	BREM	2.03	BREM	2.00	BREM	2.07	BREM	2.37	BREM
BREM	1006645	1.14	BNE	1.18	BNE	1.26	BNE	1.33	BREM	1.39	BREM	1.51	BREM	1.50	BREM	1.55	BREM	1.98	BREM
BREM	1006780	1.11	BNE	1.14	BNE	1.13	BREM	1.19	BNE	1.18	BNE	1.20	BREM	1.20	BREM	1.25	BREM	1.97	BREM
BREM	1007110	1.17	BNE	1.21	BREM	1.24	BREM	1.29	BNE	1.30	BNE	1.32	BREM	1.32	BREM	1.36	BREM	2.16	BREM
BREM	1007440	1.24	BNE	1.36	BNE	1.40	BREM	1.47	BNE	1.48	BNE	1.49	BREM	1.51	BREM	1.53	BREM	2.39	BREM
BREM	1007570	1.04	BNE	1.23	BNE	1.33	BREM	1.41	BNE	1.45	BNE	1.56	BREM	1.54	BREM	1.58	BREM	2.35	BREM
BREM	1007700	0.92	BNE	1.16	BNE	1.34	BNE	1.43	BREM	1.55	BREM	1.70	BREM	1.68	BREM	1.73	BREM	2.31	BREM
BREM	1007850	0.95	BNE	1.16	BNE	1.33	BNE	1.42	BREM	1.53	BREM	1.63	BREM	1.61	BREM	1.66	BREM	2.17	BREM
BREM	1008000	0.98	BNE	1.17	BNE	1.32	BNE	1.41	BREM	1.52	BREM	1.56	BREM	1.55	BREM	1.59	BREM	2.05	BREM
BREM	1008000	0.98	BNE	1.16	BNE	1.31	BNE	1.40	BNE	1.49	BREM	1.52	BREM	1.53	BREM	1.56	BREM	2.04	BREM
BREM	1008195	1.03	BNE	1.18	BNE	1.33	BNE	1.42	BNE	1.53	BREM	1.56	BREM	1.56	BREM	1.59	BREM	2.07	BREM
BREM	1008390	1.12	BNE	1.22	BREM	1.35	BNE	1.44	BNE	1.57	BREM	1.60	BREM	1.60	BREM	1.63	BREM	2.10	BREM
BREM	1008400	1.22	BNE	1.43	BNE	1.98	BNE	2.32	BNE	2.52	BREM	2.54	BREM	2.59	BREM	2.64	BREM	3.47	BREM
BREM	1008410	1.12	BNE	1.23	BREM	1.36	BNE	1.48	BNE	1.62	BREM	1.64	BREM	1.66	BREM	1.69	BREM	2.16	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1008415	1.03	BNE	1.23	BNE	1.39	BNE	1.48	BREM	1.61	BREM	1.63	BREM	1.64	BREM	1.68	BREM	1.83	BREM
BREM	1008420	1.02	BNE	1.24	BNE	1.41	BNE	1.51	BREM	1.64	BREM	1.67	BREM	1.67	BREM	1.71	BREM	1.86	BREM
BREM	1008540	1.09	BNE	1.33	BNE	1.49	BNE	1.58	BREM	1.71	BREM	1.73	BREM	1.74	BREM	1.78	BREM	1.94	BREM
BREM	1008660	1.16	BNE	1.45	BNE	1.57	BNE	1.67	BREM	1.83	BREM	1.96	BREM	1.96	BREM	2.03	BREM	2.29	BREM
BREM	1008935	1.00	BNE	1.22	BNE	1.37	BNE	1.49	BNE	1.65	BREM	1.75	BREM	1.75	BREM	1.82	BREM	2.06	BREM
BREM	1009210	0.87	BNE	1.06	BNE	1.22	BNE	1.35	BNE	1.50	BREM	1.58	BREM	1.58	BREM	1.66	BREM	1.92	BREM
BREM	1009398	0.71	BNE	0.90	BNE	1.03	BNE	1.10	BREM	1.15	BNE	1.18	BREM	1.21	BREM	1.25	BREM	1.35	BREM
BREM	1009585	0.60	BNE	0.78	BNE	0.89	BNE	0.95	BREM	0.99	BNE	1.03	BREM	1.05	BREM	1.08	BREM	1.19	BREM
BREM	1009585	0.60	BNE	0.78	BNE	0.89	BNE	0.95	BREM	0.99	BNE	1.03	BREM	1.05	BREM	1.08	BREM	1.17	BREM
BREM	1009630	0.63	BNE	0.82	BNE	0.96	BNE	1.02	BREM	1.06	BREM	1.10	BREM	1.13	BREM	1.16	BREM	1.26	BREM
BREM	1009675	0.66	BNE	0.86	BNE	1.04	BNE	1.16	BNE	1.27	BREM	1.29	BREM	1.31	BREM	1.34	BREM	1.49	BREM
BREM	1009748	0.58	BNE	0.81	BNE	0.95	BNE	1.02	BREM	1.09	BREM	1.11	BREM	1.12	BREM	1.16	BREM	1.28	BREM
BREM	1009820	0.52	BNE	0.76	BNE	0.87	BNE	0.93	BREM	0.97	BNE	1.00	BREM	1.03	BREM	1.05	BREM	1.19	BREM
BREM	1009820	0.52	BNE	0.76	BNE	0.86	BNE	0.92	BREM	0.95	BNE	0.98	BREM	1.01	BREM	1.03	BREM	1.36	BREM
BREM	1009920	0.72	BNE	0.95	BNE	1.08	BNE	1.15	BREM	1.21	BREM	1.23	BREM	1.27	BREM	1.30	BREM	1.42	BREM
BREM	1010020	1.23	BNE	1.39	BNE	1.46	BREM	1.59	BNE	1.77	BREM	1.86	BREM	1.88	BREM	1.91	BREM	2.11	BREM
BREM	1010150	0.94	BNE	1.12	BNE	1.20	BREM	1.30	BREM	1.39	BREM	1.45	BREM	1.46	BREM	1.49	BREM	1.64	BREM
BREM	1010280	0.77	BNE	0.95	BNE	1.03	BREM	1.11	BREM	1.15	BNE	1.19	BREM	1.21	BREM	1.24	BREM	1.34	BREM
BREM	1010490	0.74	BNE	0.94	BNE	1.05	BNE	1.13	BNE	1.26	BREM	1.34	BREM	1.35	BREM	1.38	BREM	1.50	BREM
BREM	1010700	0.71	BNE	0.93	BNE	1.09	BNE	1.25	BNE	1.40	BREM	1.54	BREM	1.55	BREM	1.58	BREM	1.73	BREM
BREM	1010795	0.82	BNE	1.04	BNE	1.21	BNE	1.37	BNE	1.55	BREM	1.73	BREM	1.74	BREM	1.78	BREM	1.96	BREM
BREM	1010890	0.97	BNE	1.20	BNE	1.35	BNE	1.52	BNE	1.73	BREM	1.97	BREM	2.02	BREM	2.17	BREM	2.44	BREM
BREM	1011105	0.93	BNE	1.11	BNE	1.17	BREM	1.26	BREM	1.32	BREM	1.45	BREM	1.47	BREM	1.54	BREM	1.81	BREM
BREM	1011320	0.90	BNE	1.05	BNE	1.11	BREM	1.16	BNE	1.16	BNE	1.19	BREM	1.22	BREM	1.26	BREM	1.43	BREM
BREM	1011510	0.97	BNE	1.16	BNE	1.22	BREM	1.32	BREM	1.37	BREM	1.50	BREM	1.51	BREM	1.56	BREM	1.73	BREM
BREM	1011700	1.06	BNE	1.33	BNE	1.52	BNE	1.69	BNE	1.93	BREM	2.15	BREM	2.17	BREM	2.24	BREM	2.51	BREM
BREM	1011745	1.07	BNE	1.34	BNE	1.53	BNE	1.66	BREM	1.89	BREM	2.10	BREM	2.12	BREM	2.18	BREM	2.44	BREM
BREM	1011790	1.08	BNE	1.35	BNE	1.53	BNE	1.67	BREM	1.86	BREM	2.05	BREM	2.07	BREM	2.13	BREM	2.38	BREM
BREM	1011800	1.13	BNE	1.42	BNE	1.62	BNE	1.79	BREM	2.05	BREM	2.34	BREM	2.44	BREM	2.75	BREM	5.85	BREM
BREM	1011810	1.08	BNE	1.36	BNE	1.54	BNE	1.68	BREM	1.87	BREM	2.07	BREM	2.08	BREM	2.15	BREM	2.42	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1011930	0.85	BNE	1.08	BNE	1.23	BNE	1.34	BREM	1.54	BREM	1.72	BREM	1.74	BREM	1.83	BREM	2.09	BREM
BREM	1012050	0.70	BNE	0.90	BNE	1.02	BNE	1.13	BNE	1.30	BREM	1.47	BREM	1.49	BREM	1.60	BREM	1.89	BREM
BREM	1012060	1.04	BNE	1.22	BNE	1.32	BREM	1.44	BNE	1.54	BREM	1.70	BREM	1.72	BREM	1.87	BREM	3.53	BREM
BREM	1012070	0.71	BNE	0.90	BNE	1.02	BNE	1.13	BNE	1.31	BREM	1.48	BREM	1.50	BREM	1.61	BREM	1.94	BREM
BREM	1012135	0.81	BNE	1.02	BNE	1.15	BNE	1.25	BREM	1.43	BREM	1.57	BREM	1.59	BREM	1.65	BREM	1.85	BREM
BREM	1012200	0.96	BNE	1.20	BNE	1.30	BNE	1.43	BREM	1.57	BREM	1.70	BREM	1.71	BREM	1.76	BREM	2.00	BREM
BREM	1012535	0.69	BNE	0.85	BNE	0.96	BNE	1.07	BNE	1.24	BREM	1.35	BREM	1.36	BREM	1.40	BREM	1.59	BREM
BREM	1012870	0.53	BNE	0.66	BNE	0.76	BNE	0.88	BNE	1.03	BREM	1.12	BREM	1.13	BREM	1.22	BREM	1.39	BREM
BREM	1013125	0.67	BNE	0.80	BNE	0.88	BNE	0.95	BREM	1.00	BREM	1.04	BREM	1.09	BREM	1.13	BREM	1.45	BREM
BREM	1013380	0.88	BNE	1.04	BNE	1.10	BREM	1.17	BREM	1.21	BREM	1.25	BREM	1.32	BREM	1.36	BREM	1.56	BREM
BREM	1013540	0.85	BNE	0.99	BNE	1.06	BREM	1.09	BNE	1.11	BREM	1.15	BREM	1.21	BREM	1.25	BREM	1.45	BREM
BREM	1013700	0.83	BNE	0.95	BNE	1.01	BREM	1.05	BNE	1.07	BNE	1.08	BNE	1.12	BREM	1.16	BREM	1.34	BREM
BREM	1013960	0.89	BNE	1.05	BNE	1.11	BREM	1.17	BREM	1.21	BREM	1.25	BREM	1.32	BREM	1.37	BREM	1.78	BREM
BREM	1014220	0.99	BNE	1.20	BNE	1.31	BREM	1.44	BNE	1.65	BREM	1.78	BREM	1.80	BREM	1.89	BREM	2.66	BREM
BREM	1014430	0.92	BNE	1.14	BNE	1.27	BNE	1.43	BNE	1.66	BREM	1.84	BREM	1.88	BREM	2.02	BREM	2.94	BREM
BREM	1014640	0.87	BNE	1.08	BNE	1.24	BNE	1.42	BNE	1.66	BREM	1.91	BREM	1.99	BREM	2.19	BREM	3.28	BREM
BREM	1014910	0.93	BNE	1.15	BNE	1.30	BNE	1.46	BNE	1.70	BREM	1.93	BREM	2.00	BREM	2.19	BREM	3.02	BREM
BREM	1015180	0.99	BNE	1.23	BNE	1.38	BNE	1.51	BREM	1.74	BREM	1.96	BREM	2.01	BREM	2.19	BREM	2.86	BREM
BREM	1015313	0.48	BNE	0.55	BNE	0.59	BREM	0.74	BNE	0.88	BREM	1.06	BREM	1.14	BREM	1.30	BREM	2.32	BREM
BREM	1015445	0.33	BNE	0.36	BREM	0.38	BREM	0.49	BNE	0.59	BNE	0.72	BREM	0.79	BREM	0.93	BREM	2.05	BREM
BREM	1015445	0.33	BNE	0.36	BREM	0.38	BREM	0.49	BNE	0.59	BNE	0.72	BREM	0.79	BREM	0.93	BREM	1.52	BREM
BREM	1015578	0.44	BNE	0.50	BNE	0.54	BREM	0.62	BNE	0.73	BREM	0.86	BREM	0.91	BREM	1.03	BREM	1.52	BREM
BREM	1015710	0.77	BNE	0.90	BNE	0.95	BREM	1.00	BNE	1.02	BREM	1.07	BREM	1.14	BREM	1.18	BREM	1.54	BREM
BREM	1015910	0.38	BNE	0.49	BNE	0.57	BNE	0.67	BNE	0.79	BREM	0.91	BREM	0.95	BREM	1.06	BREM	1.51	BREM
BREM	1016110	0.25	BNE	0.35	BNE	0.43	BNE	0.55	BNE	0.66	BREM	0.79	BREM	0.86	BREM	0.98	BREM	1.49	BREM
BREM	1016110	0.25	BNE	0.35	BNE	0.43	BNE	0.55	BNE	0.66	BREM	0.79	BREM	0.86	BREM	0.97	BREM	1.33	BREM
BREM	1016310	0.37	BNE	0.51	BNE	0.59	BNE	0.70	BNE	0.82	BREM	0.95	BREM	1.00	BREM	1.10	BREM	1.44	BREM
BREM	1016510	0.76	BNE	0.96	BNE	1.05	BREM	1.12	BREM	1.16	BREM	1.19	BREM	1.28	BREM	1.32	BREM	1.58	BREM
BREM	1016795	0.75	BNE	0.92	BNE	1.00	BREM	1.08	BREM	1.19	BREM	1.31	BREM	1.34	BREM	1.45	BREM	1.85	BREM
BREM	1017080	0.73	BNE	0.89	BNE	0.99	BNE	1.11	BREM	1.29	BREM	1.45	BREM	1.52	BREM	1.68	BREM	2.25	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1017415	0.70	BNE	0.83	BNE	0.90	BNE	1.01	BNE	1.19	BREM	1.37	BREM	1.44	BREM	1.61	BREM	2.12	BREM
BREM	1017750	0.67	BNE	0.79	BNE	0.85	BREM	0.94	BNE	1.11	BREM	1.29	BREM	1.37	BREM	1.54	BREM	2.01	BREM
BREM	1017945	0.76	BNE	0.86	BNE	0.92	BREM	0.96	BREM	1.13	BREM	1.30	BREM	1.37	BREM	1.52	BREM	2.01	BREM
BREM	1018140	0.89	BNE	0.99	BNE	1.03	BREM	1.05	BNE	1.14	BREM	1.30	BREM	1.36	BREM	1.50	BREM	2.01	BREM
BREM	1018230	0.46	BNE	0.61	BNE	0.69	BNE	0.86	BNE	1.03	BREM	1.22	BREM	1.30	BREM	1.46	BREM	2.01	BREM
BREM	1018320	0.31	BNE	0.47	BNE	0.59	BNE	0.79	BNE	0.95	BREM	1.15	BREM	1.26	BREM	1.43	BREM	2.01	BREM
BREM	1018320	0.31	BNE	0.47	BNE	0.59	BNE	0.79	BNE	0.95	BREM	1.15	BREM	1.26	BREM	1.45	BREM	2.25	BREM
BREM	1018410	0.43	BNE	0.61	BNE	0.73	BNE	0.90	BNE	1.07	BREM	1.23	BREM	1.30	BREM	1.46	BREM	2.13	BREM
BREM	1018500	0.71	BNE	0.90	BNE	0.97	BREM	1.07	BREM	1.23	BREM	1.33	BREM	1.35	BREM	1.47	BREM	2.03	BREM
BREM	1018565	0.52	BNE	0.61	BNE	0.70	BNE	0.85	BNE	1.01	BREM	1.16	BREM	1.22	BREM	1.37	BREM	1.97	BREM
BREM	1018630	0.41	BNE	0.46	BNE	0.55	BNE	0.71	BNE	0.85	BREM	1.03	BREM	1.12	BREM	1.28	BREM	1.91	BREM
BREM	1018630	0.41	BNE	0.46	BNE	0.55	BNE	0.71	BNE	0.85	BREM	1.03	BREM	1.12	BREM	1.28	BREM	2.07	BREM
BREM	1018695	0.55	BNE	0.65	BNE	0.74	BNE	0.84	BREM	0.97	BREM	1.06	BREM	1.08	BREM	1.18	BREM	1.70	BREM
BREM	1018760	0.87	BNE	1.08	BNE	1.17	BREM	1.27	BREM	1.33	BREM	1.34	BREM	1.44	BREM	1.48	BREM	1.60	BREM
BREM	1018955	0.74	BNE	0.87	BNE	0.93	BREM	1.00	BREM	1.06	BREM	1.06	BREM	1.13	BREM	1.16	BREM	1.38	BREM
BREM	1019150	0.64	BNE	0.73	BNE	0.78	BREM	0.83	BREM	0.88	BREM	0.88	BREM	0.94	BREM	0.96	BREM	1.33	BREM
BREM	1019365	0.70	BNE	0.83	BNE	0.89	BREM	0.94	BREM	0.96	BREM	0.96	BREM	1.07	BREM	1.10	BREM	1.24	BREM
BREM	1019580	0.77	BNE	0.97	BNE	1.05	BREM	1.10	BREM	1.12	BREM	1.08	BREM	1.26	BREM	1.28	BREM	1.37	BREM
BREM	1019790	0.84	BNE	1.02	BNE	1.09	BREM	1.13	BREM	1.14	BREM	1.14	BREM	1.30	BREM	1.32	BREM	1.41	BREM
BREM	1020000	0.91	BNE	1.06	BNE	1.14	BREM	1.17	BREM	1.24	BREM	1.26	BREM	1.34	BREM	1.37	BREM	1.50	BREM
BREM	1020150	0.45	BNE	0.58	BNE	0.62	BREM	0.67	BREM	0.78	BREM	0.86	BREM	0.87	BREM	0.92	BREM	1.23	BREM
BREM	1020300	0.30	BNE	0.40	BNE	0.43	BREM	0.48	BREM	0.58	BREM	0.66	BREM	0.69	BREM	0.75	BREM	1.07	BREM
BREM	1020300	0.31	BNE	0.40	BNE	0.45	BREM	0.51	BNE	0.59	BREM	0.67	BREM	0.71	BREM	0.76	BREM	1.09	BREM
BREM	1020370	0.38	BNE	0.44	BNE	0.48	BREM	0.50	BREM	0.57	BREM	0.62	BREM	0.64	BREM	0.68	BREM	1.01	BREM
BREM	1020440	0.51	BNE	0.55	BREM	0.56	BREM	0.55	BREM	0.56	BREM	0.67	BREM	0.58	BREM	0.61	BREM	0.94	BREM
BREM	1020440	0.51	BNE	0.55	BREM	0.56	BREM	0.55	BREM	0.55	BREM	0.67	BREM	0.58	BREM	0.58	BREM	0.87	BREM
BREM	1020445	0.53	BNE	0.57	BREM	0.57	BREM	0.57	BREM	0.56	BREM	0.74	BREM	0.59	BREM	0.59	BREM	0.87	BREM
BREM	1020450	0.56	BNE	0.60	BREM	0.59	BREM	0.59	BREM	0.60	BNE	0.83	BREM	0.61	BREM	0.61	BREM	0.87	BREM
BREM	1020475	0.58	BNE	0.61	BREM	0.60	BREM	0.60	BREM	0.59	BREM	0.84	BREM	0.63	BREM	0.63	BREM	0.86	BREM
BREM	1020500	0.59	BNE	0.63	BREM	0.62	BREM	0.62	BREM	0.61	BREM	0.84	BREM	0.65	BREM	0.64	BREM	0.86	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1020500	0.59	BNE	0.63	BREM	0.63	BREM	0.63	BREM	0.63	BREM	0.82	BREM	0.66	BREM	0.66	BREM	0.92	BREM
BREM	1020710	0.70	BNE	0.74	BREM	0.76	BREM	0.75	BREM	0.75	BREM	0.82	BREM	0.78	BREM	0.78	BREM	0.89	BREM
BREM	1020920	0.91	BNE	1.03	BNE	1.09	BREM	1.11	BREM	1.12	BREM	1.14	BREM	1.15	BREM	1.16	BREM	1.19	BREM
BREM	1021190	0.86	BNE	1.00	BNE	1.09	BREM	1.11	BREM	1.11	BREM	1.13	BREM	1.14	BREM	1.14	BREM	1.17	BREM
BREM	1021460	0.81	BNE	0.98	BNE	1.09	BREM	1.12	BREM	1.13	BREM	1.15	BREM	1.15	BREM	1.16	BREM	1.20	BREM
BREM	1021880	0.86	BNE	1.04	BNE	1.16	BREM	1.19	BREM	1.21	BREM	1.24	BREM	1.23	BREM	1.24	BREM	1.29	BREM
BREM	1022300	0.92	BNE	1.11	BNE	1.25	BREM	1.28	BREM	1.29	BREM	1.32	BREM	1.31	BREM	1.33	BREM	1.37	BREM
BREM	1022625	0.86	BNE	1.00	BREM	1.07	BREM	1.09	BREM	1.10	BREM	1.13	BREM	1.12	BREM	1.14	BREM	1.18	BREM
BREM	1022950	0.80	BNE	0.93	BREM	0.97	BREM	0.97	BREM	0.98	BREM	0.99	BREM	1.00	BREM	1.01	BREM	1.04	BREM
BREM	1023220	0.83	BNE	1.00	BREM	1.06	BREM	1.07	BREM	1.08	BREM	1.09	BREM	1.10	BREM	1.10	BREM	1.13	BREM
BREM	1023490	0.86	BNE	1.10	BNE	1.31	BREM	1.41	BREM	1.40	BREM	1.43	BREM	1.43	BREM	1.44	BREM	1.48	BREM
BREM	1023500	0.96	BNE	1.26	BNE	1.47	BREM	1.65	BREM	1.79	BREM	1.95	BREM	2.24	BREM	2.74	BREM	5.10	BREM
BREM	1023510	0.86	BNE	1.11	BNE	1.31	BREM	1.41	BREM	1.41	BREM	1.44	BREM	1.44	BREM	1.46	BREM	1.49	BREM
BREM	1023690	0.78	BNE	0.99	BNE	1.17	BREM	1.27	BREM	1.30	BREM	1.30	BREM	1.31	BREM	1.31	BREM	1.35	BREM
BREM	1023870	0.71	BNE	0.90	BREM	1.06	BREM	1.19	BREM	1.27	BREM	1.27	BREM	1.28	BREM	1.29	BREM	1.51	BREM
BREM	1024045	0.80	BNE	1.01	BREM	1.18	BREM	1.33	BREM	1.44	BREM	1.49	BREM	1.54	BREM	1.56	BREM	1.77	BREM
BREM	1024220	0.92	BNE	1.16	BREM	1.33	BREM	1.49	BREM	1.76	BREM	1.93	BREM	2.04	BREM	2.12	BREM	2.18	BREM
BREM	1024370	0.90	BNE	1.13	BREM	1.28	BREM	1.37	BREM	1.49	BREM	1.56	BREM	1.60	BREM	1.65	BREM	1.97	BREM
BREM	1024520	0.88	BNE	1.11	BREM	1.23	BREM	1.29	BREM	1.30	BREM	1.32	BREM	1.32	BREM	1.36	BREM	1.82	BREM
BREM	1024635	0.79	BNE	1.02	BREM	1.16	BREM	1.24	BREM	1.33	BREM	1.39	BREM	1.45	BREM	1.54	BREM	2.21	BREM
BREM	1024750	0.72	BNE	0.95	BREM	1.11	BREM	1.21	BREM	1.38	BREM	1.50	BREM	1.62	BREM	1.78	BREM	2.82	BREM
BREM	1025025	0.70	BNE	0.93	BREM	1.08	BREM	1.11	BREM	1.19	BREM	1.25	BREM	1.32	BREM	1.41	BREM	2.11	BREM
BREM	1025300	0.69	BNE	0.91	BREM	1.06	BREM	1.07	BREM	1.04	BREM	1.08	BREM	1.11	BREM	1.17	BREM	1.68	BREM
BREM	1025485	0.78	BNE	1.03	BREM	1.19	BREM	1.20	BREM	1.24	BREM	1.30	BREM	1.37	BREM	1.47	BREM	2.31	BREM
BREM	1025670	0.91	BNE	1.19	BREM	1.36	BREM	1.44	BREM	1.54	BREM	1.66	BREM	1.79	BREM	1.98	BREM	3.65	BREM
BREM	1025795	0.87	BNE	1.17	BREM	1.38	BREM	1.51	BREM	1.65	BREM	1.77	BREM	1.91	BREM	2.10	BREM	3.12	BREM
BREM	1025920	0.84	BNE	1.14	BREM	1.41	BREM	1.60	BREM	1.77	BREM	1.90	BREM	2.04	BREM	2.25	BREM	2.72	BREM
BREM	1026035	0.80	BNE	1.10	BREM	1.34	BREM	1.50	BREM	1.56	BREM	1.52	BREM	1.55	BREM	1.57	BREM	2.06	BREM
BREM	1026150	0.77	BNE	1.06	BREM	1.27	BREM	1.41	BREM	1.46	BREM	1.44	BREM	1.46	BREM	1.46	BREM	1.66	BREM
BREM	1026355	0.80	BNE	1.12	BREM	1.38	BREM	1.58	BREM	1.65	BREM	1.63	BREM	1.65	BREM	1.65	BREM	2.24	BREM

Table A.3 (continued)

Branch	Chainage (m)	ARI 2 y		5 y		10 y		20 y		50 y		100 y		200 y		500 y		PMP	
BREM	1026560	0.83	BNE	1.19	BREM	1.52	BREM	1.79	BREM	2.11	BREM	2.14	BREM	2.21	BREM	2.35	BREM	3.47	BREM
BREM	1026830	0.86	BNE	1.25	BREM	1.57	BREM	1.73	BREM	1.89	BREM	1.91	BREM	1.91	BREM	1.91	BREM	1.95	BREM
BREM	1027100	0.90	BNE	1.32	BREM	1.62	BREM	1.67	BREM	1.71	BREM	1.72	BREM	1.72	BREM	1.72	BREM	1.74	BREM
BREM	1027370	0.86	BNE	1.29	BREM	1.67	BREM	1.88	BREM	2.07	BREM	2.10	BREM	2.10	BREM	2.10	BREM	2.10	BREM
BREM	1027640	0.82	BNE	1.25	BREM	1.72	BREM	2.15	BREM	2.63	BREM	2.92	BREM	3.12	BREM	3.34	BREM	3.74	BREM
BREM	1027740	0.84	BNE	1.29	BREM	1.79	BREM	2.25	BREM	2.82	BREM	3.15	BREM	3.40	BREM	3.68	BREM	3.79	BREM
BREM	1027840	0.86	BNE	1.34	BREM	1.87	BREM	2.36	BREM	3.03	BREM	3.41	BREM	3.72	BREM	4.11	BREM	4.26	BREM
BREM	1028015	0.94	BNE	1.51	BREM	2.15	BREM	2.77	BREM	3.66	BREM	4.17	BREM	4.55	BREM	5.03	BREM	5.31	BREM
BREM	1028190	1.04	BNE	1.73	BREM	2.52	BREM	3.37	BREM	4.62	BREM	5.34	BREM	5.86	BREM	6.48	BREM	10.92	BREM
BREM	1028340	1.02	BNE	1.84	BREM	2.84	BREM	3.99	BREM	5.75	BREM	6.95	BREM	7.87	BREM	9.00	BREM	17.69	BREM
BREM	1028490	1.00	BNE	7.12	BREM	7.12	BREM	7.12	BREM	7.63	BREM	13.16	BNE	11.99	BREM	14.73	BREM	46.68	BREM

Table A.4 Comparison of peak water elevations (m AHD)

Branch	Chainage	2y KBR	2y SKM	2y Diff.	2y Critical	5y KBR	5y SKM	5y Diff.	5y Critical	10y KBR	10y SKM	10y Diff.	10y Critical
BREM	1000000	15.29	16.34	-1.05	BNE	17.86	19.27	-1.41	BNE	19.71	21.37	-1.66	BNE
BREM	1000700	15.00	15.96	-0.96	BNE	17.40	18.83	-1.43	BNE	19.20	20.92	-1.72	BNE
BREM	1001120	14.60	15.68	-1.08	BNE	17.18	18.65	-1.46	BNE	19.03	20.77	-1.73	BNE
BREM	1001700	13.93	15.16	-1.23	BNE	16.81	18.29	-1.48	BNE	18.70	20.45	-1.75	BNE
BREM	1002300	13.27	14.43	-1.16	BNE	16.28	17.64	-1.36	BNE	18.23	19.84	-1.61	BNE
BREM	1002700	12.81	13.93	-1.12	BNE	15.89	17.18	-1.29	BNE	17.84	19.38	-1.54	BNE
BREM	1003130	12.39	13.41	-1.03	BNE	15.53	16.71	-1.18	BNE	17.45	18.92	-1.47	BNE
BREM	1003200	12.34	13.37	-1.03	BNE	15.49	16.67	-1.18	BNE	17.41	18.88	-1.47	BNE
BREM	1003700	11.65	12.80	-1.15	BNE	15.19	16.30	-1.11	BNE	17.21	18.56	-1.34	BNE
BREM	1003840	11.64	12.56	-0.93	BNE	15.17	16.18	-1.01	BNE	17.21	18.46	-1.25	BNE
BREM	1004150	11.61	12.26	-0.65	BNE	15.14	15.98	-0.84	BNE	17.17	18.28	-1.11	BNE
BREM	1004320	11.58	12.12	-0.54	BNE	15.13	15.86	-0.73	BNE	17.16	18.15	-1.00	BNE
BREM	1004590	11.45	11.78	-0.33	BNE	15.03	15.56	-0.53	BNE	17.09	17.97	-0.87	BNE
BREM	1004610	11.41	11.76	-0.35	BNE	14.71	15.34	-0.63	BNE	16.95	17.92	-0.97	BNE
BREM	1004650	11.37	11.72	-0.35	BNE	14.65	15.33	-0.68	BNE	16.93	17.93	-1.00	BNE
BREM	1004700	11.32	11.66	-0.35	BNE	14.59	15.31	-0.73	BNE	16.90	17.93	-1.03	BNE
BREM	1005140	11.07	11.41	-0.34	BNE	14.23	15.07	-0.85	BNE	16.66	17.72	-1.06	BNE
BREM	1005740	10.87	11.13	-0.25	BNE	14.00	14.76	-0.77	BNE	16.43	17.41	-0.97	BNE
BREM	1006090	10.68	10.84	-0.15	BNE	13.83	14.43	-0.59	BNE	16.29	17.06	-0.77	BNE
BREM	1006250	10.61	10.78	-0.18	BNE	13.76	14.41	-0.64	BNE	16.23	17.06	-0.83	BNE
BREM	1006490	10.40	10.60	-0.21	BNE	13.56	14.22	-0.66	BNE	16.03	16.86	-0.83	BNE
BREM	1006510	10.37	10.58	-0.21	BNE	13.52	14.19	-0.67	BNE	15.99	16.82	-0.83	BNE
BREM	1006780	10.06	10.41	-0.36	BNE	13.34	14.09	-0.74	BNE	15.88	16.75	-0.87	BNE
BREM	1007440	9.23	9.90	-0.67	BNE	12.78	13.61	-0.84	BNE	15.47	16.29	-0.82	BNE
BREM	1007700	9.05	9.78	-0.73	BNE	12.58	13.49	-0.91	BNE	15.30	16.19	-0.89	BNE
BREM	1008000	8.88	9.59	-0.71	BNE	12.41	13.27	-0.86	BNE	15.14	15.96	-0.82	BNE
BREM	1008390	8.59	9.25	-0.66	BNE	12.17	12.95	-0.78	BNE	14.93	15.69	-0.77	BNE
BREM	1008410	8.57	9.23	-0.65	BNE	12.14	12.92	-0.78	BNE	14.82	15.49	-0.68	BNE
BREM	1008420	8.57	9.22	-0.65	BNE	12.13	12.90	-0.77	BNE	14.80	15.45	-0.65	BNE
BREM	1008660	8.37	9.00	-0.63	BNE	11.92	12.65	-0.73	BNE	14.61	15.19	-0.57	BNE
BREM	1009210	8.05	8.54	-0.49	BNE	11.58	12.12	-0.54	BNE	14.31	14.63	-0.32	BNE
BREM	1009585	7.96	8.33	-0.37	BNE	11.48	11.86	-0.38	BNE	14.19	14.35	-0.15	BNE
BREM	1009675	7.94	8.29	-0.36	BNE	11.45	11.82	-0.37	BNE	14.15	14.30	-0.15	BNE
BREM	1009820	7.92	8.22	-0.30	BNE	11.42	11.72	-0.30	BNE	14.11	14.19	-0.08	BNE
BREM	1010020	7.81	8.00	-0.19	BNE	11.27	11.46	-0.19	BNE	13.95	13.91	0.04	BNE
BREM	1010280	7.67	7.77	-0.10	BNE	11.15	11.23	-0.08	BNE	13.87	13.71	0.16	BNE
BREM	1010700	7.55	7.59	-0.04	BNE	10.99	11.01	-0.02	BNE	13.70	13.46	0.24	BNE
BREM	1010890	7.46	7.47	-0.01	BNE	10.88	10.85	0.03	BNE	13.60	13.29	0.31	BNE
BREM	1011320	7.19	7.13	0.06	BNE	10.68	10.53	0.15	BNE	13.44	13.00	0.44	BNE
BREM	1011700	6.92	6.77	0.15	BNE	10.43	10.13	0.29	BNE	13.19	12.60	0.60	BNE
BREM	1011790	6.85	6.68	0.17	BNE	10.37	10.05	0.32	BNE	13.14	12.52	0.61	BNE
BREM	1011810	6.84	6.66	0.17	BNE	10.33	10.01	0.32	BNE	13.09	12.48	0.62	BNE
BREM	1012050	6.78	6.58	0.20	BNE	10.28	9.94	0.35	BNE	13.05	12.41	0.63	BNE
BREM	1012070	6.77	6.52	0.24	BNE	10.27	9.86	0.41	BNE	13.03	12.33	0.70	BNE
BREM	1012200	6.73	6.48	0.25	BNE	10.22	9.80	0.42	BNE	12.99	12.26	0.72	BNE
BREM	1012870	6.67	6.43	0.24	BNE	10.18	9.77	0.41	BNE	12.95	12.24	0.70	BNE
BREM	1013380	6.59	6.36	0.23	BNE	10.11	9.69	0.42	BNE	12.89	12.16	0.72	BNE

Chainage	20y KBR	20y SKM	20y Diff.	20y Critical	50y KBR	50y SKM	50y Diff.	50y Critical	100y KBR	100y SKM	100y Diff.	100y Critical
1000000	22.10	23.81	-1.71	BNE	24.29	25.73	-1.44	BNE	25.66	27.17	-1.51	BREM
1000700	21.62	23.41	-1.80	BNE	23.73	25.36	-1.62	BNE	25.15	26.79	-1.64	BREM
1001120	21.49	23.28	-1.79	BNE	23.54	25.23	-1.68	BNE	24.97	26.65	-1.68	BREM
1001700	21.22	23.02	-1.80	BNE	23.28	24.99	-1.71	BNE	24.71	26.42	-1.71	BNE
1002300	20.81	22.43	-1.61	BNE	22.92	24.44	-1.53	BNE	24.46	25.90	-1.44	BNE
1002700	20.47	21.96	-1.49	BNE	22.59	23.97	-1.39	BNE	24.18	25.44	-1.26	BNE
1003130	20.07	21.50	-1.43	BNE	22.16	23.52	-1.36	BNE	23.74	25.00	-1.26	BNE
1003200	20.02	21.45	-1.43	BNE	22.11	23.48	-1.37	BNE	23.69	24.96	-1.27	BNE
1003700	19.89	21.16	-1.27	BNE	21.98	23.20	-1.22	BNE	23.57	24.73	-1.16	BNE
1003840	19.89	21.08	-1.20	BNE	21.98	23.12	-1.14	BNE	23.57	24.67	-1.10	BNE
1004150	19.83	20.95	-1.12	BNE	21.95	23.05	-1.10	BNE	23.55	24.62	-1.07	BNE
1004320	19.82	20.85	-1.03	BNE	21.93	22.98	-1.05	BNE	23.54	24.57	-1.03	BNE
1004590	19.79	20.72	-0.94	BNE	21.91	22.88	-0.97	BNE	23.52	24.47	-0.95	BNE
1004610	19.72	20.70	-0.98	BNE	21.86	22.86	-1.00	BNE	23.47	24.45	-0.98	BNE
1004650	19.71	20.72	-1.01	BNE	21.85	22.89	-1.04	BNE	23.47	24.48	-1.01	BNE
1004700	19.69	20.74	-1.05	BNE	21.83	22.92	-1.09	BNE	23.45	24.52	-1.07	BNE
1005140	19.46	20.53	-1.07	BNE	21.56	22.70	-1.14	BNE	23.22	24.31	-1.09	BNE
1005740	19.20	20.18	-0.98	BNE	21.23	22.33	-1.10	BNE	22.88	23.92	-1.05	BNE
1006090	19.06	19.79	-0.73	BNE	21.08	21.89	-0.81	BNE	22.74	23.45	-0.71	BNE
1006250	18.99	19.81	-0.82	BNE	20.99	21.94	-0.95	BNE	22.64	23.53	-0.89	BNE
1006490	18.77	19.61	-0.84	BNE	20.74	21.72	-0.98	BNE	22.34	23.30	-0.97	BNE
1006510	18.71	19.54	-0.83	BNE	20.67	21.65	-0.98	BNE	22.27	23.23	-0.96	BNE
1006780	18.62	19.50	-0.88	BNE	20.60	21.62	-1.02	BNE	22.18	23.20	-1.02	BNE
1007440	18.28	18.99	-0.72	BNE	20.28	21.04	-0.76	BNE	21.88	22.57	-0.69	BNE
1007700	18.10	18.92	-0.82	BNE	20.10	21.00	-0.91	BNE	21.69	22.58	-0.90	BNE
1008000	17.90	18.66	-0.76	BNE	19.89	20.70	-0.81	BNE	21.46	22.23	-0.77	BNE
1008390	17.60	18.43	-0.83	BNE	19.55	20.49	-0.94	BNE	21.17	22.05	-0.88	BNE
1008410	17.39	18.27	-0.88	BNE	19.39	20.35	-0.96	BNE	21.04	21.92	-0.88	BNE
1008420	17.39	18.21	-0.82	BNE	19.41	20.28	-0.87	BNE	21.07	21.84	-0.78	BNE
1008660	17.13	17.92	-0.79	BNE	19.09	19.95	-0.86	BNE	20.75	21.50	-0.75	BNE
1009210	16.79	17.32	-0.54	BNE	18.69	19.30	-0.61	BNE	20.27	20.82	-0.55	BNE
1009585	16.67	17.01	-0.33	BNE	18.60	18.96	-0.36	BNE	20.19	20.49	-0.30	BNE
1009675	16.60	16.95	-0.35	BNE	18.54	18.91	-0.37	BNE	20.14	20.44	-0.30	BNE
1009820	16.57	16.86	-0.29	BNE	18.50	18.82	-0.32	BNE	20.10	20.35	-0.25	BNE
1010020	16.39	16.55	-0.16	BNE	18.30	18.47	-0.16	BNE	19.94	19.98	-0.05	BNE
1010280	16.32	16.37	-0.05	BNE	18.18	18.29	-0.11	BNE	19.77	19.83	-0.06	BNE
1010700	16.12	16.10	0.02	BNE	17.94	17.99	-0.04	BNE	19.50	19.52	-0.01	BNE
1010890	15.99	15.91	0.08	BNE	17.78	17.77	0.01	BNE	19.30	19.30	0.01	BNE
1011320	15.85	15.65	0.20	BNE	17.66	17.52	0.14	BNE	19.18	19.10	0.08	BNE
1011700	15.58	15.24	0.34	BNE	17.35	17.08	0.27	BNE	18.87	18.72	0.16	BNE
1011790	15.52	15.17	0.34	BNE	17.28	17.03	0.25	BNE	18.78	18.68	0.11	BNE
1011810	15.48	15.14	0.34	BNE	17.23	16.99	0.24	BNE	18.73	18.63	0.10	BNE
1012050	15.43	15.08	0.36	BNE	17.17	16.94	0.23	BNE	18.65	18.60	0.05	BNE
1012070	15.41	14.98	0.43	BNE	17.15	16.91	0.23	BNE	18.55	18.51	0.04	BNE
1012200	15.36	14.90	0.46	BNE	17.09	16.85	0.25	BNE	18.50	18.45	0.05	BNE
1012870	15.31	14.88	0.43	BNE	17.01	16.83	0.18	BNE	18.39	18.44	-0.05	BNE
1013380	15.27	14.83	0.44	BNE	16.96	16.79	0.17	BNE	18.35	18.41	-0.06	BNE

Chainage	200y KBR	200y SKM	200y Diff.	200y Critical	500y KBR	500y SKM	500y Diff.	500y Critical	2000y KBR	2000y SKM	2000y Diff.	2000y Critical
1000000	26.31	28.05	-1.74	BREM	27.61	29.77	-2.16	BREM	36.81	42.04	-5.23	BREM
1000700	25.97	27.71	-1.74	BREM	27.40	29.44	-2.05	BREM	36.74	41.74	-5.00	BREM
1001120	25.83	27.58	-1.75	BREM	27.30	29.32	-2.02	BREM	36.68	41.60	-4.92	BREM
1001700	25.62	27.37	-1.75	BREM	27.30	29.32	-2.01	BREM	36.54	41.40	-4.86	BREM
1002300	25.42	26.86	-1.44	BREM	26.93	28.63	-1.70	BREM	36.39	40.84	-4.46	BREM
1002700	25.17	26.41	-1.25	BREM	26.71	28.20	-1.50	BREM	36.12	40.42	-4.30	BREM
1003130	24.72	26.00	-1.28	BREM	26.32	27.84	-1.52	BREM	35.83	40.13	-4.30	BREM
1003200	24.68	25.97	-1.29	BREM	26.28	27.82	-1.54	BREM	35.82	40.12	-4.31	BREM
1003700	24.57	25.78	-1.21	BREM	26.19	27.69	-1.50	BREM	35.78	40.04	-4.25	BREM
1003840	24.57	25.73	-1.16	BREM	26.19	27.66	-1.47	BREM	35.78	40.02	-4.24	BREM
1004150	24.55	25.69	-1.14	BREM	26.18	27.62	-1.45	BREM	35.77	39.99	-4.21	BREM
1004320	24.55	25.65	-1.11	BREM	26.17	27.59	-1.42	BREM	35.77	39.94	-4.17	BREM
1004590	24.53	25.55	-1.02	BREM	26.16	27.51	-1.35	BREM	35.76	39.79	-4.03	BREM
1004610	24.48	25.53	-1.05	BREM	26.11	27.49	-1.38	BREM	35.65	39.76	-4.11	BREM
1004650	24.48	25.57	-1.09	BREM	26.11	27.53	-1.42	BREM	35.65	39.86	-4.21	BREM
1004700	24.47	25.62	-1.15	BREM	26.10	27.59	-1.49	BREM	35.64	40.10	-4.46	BREM
1005140	24.25	25.40	-1.15	BREM	25.93	27.38	-1.45	BREM	35.52	39.81	-4.29	BREM
1005740	23.91	24.99	-1.08	BREM	25.64	26.95	-1.31	BREM	35.22	39.14	-3.93	BREM
1006090	23.78	24.47	-0.69	BREM	25.53	26.39	-0.86	BREM	35.09	37.86	-2.77	BREM
1006250	23.67	24.58	-0.91	BREM	25.43	26.56	-1.13	BREM	34.99	38.74	-3.75	BREM
1006490	23.32	24.32	-1.01	BREM	25.04	26.29	-1.26	BREM	34.75	38.21	-3.47	BREM
1006510	23.24	24.26	-1.02	BREM	24.92	25.97	-1.05	BREM	33.57	37.71	-4.15	BREM
1006780	23.12	24.25	-1.13	BREM	24.71	25.97	-1.26	BREM	33.44	37.93	-4.49	BNE
1007440	22.80	23.54	-0.74	BREM	24.37	25.16	-0.79	BREM	33.42	36.12	-2.70	BNE
1007700	22.60	23.60	-1.00	BREM	24.18	25.30	-1.12	BREM	33.41	37.26	-3.84	BNE
1008000	22.32	23.19	-0.87	BREM	23.93	24.83	-0.89	BREM	33.41	36.10	-2.69	BNE
1008390	21.96	23.01	-1.04	BREM	23.59	24.67	-1.08	BREM	33.40	36.27	-2.87	BNE
1008410	21.83	22.87	-1.04	BREM	23.47	24.59	-1.12	BREM	33.39	36.15	-2.76	BNE
1008420	21.86	22.78	-0.92	BREM	23.52	24.51	-1.00	BREM	33.39	36.05	-2.66	BNE
1008660	21.53	22.40	-0.86	BREM	23.25	24.10	-0.85	BREM	33.39	35.46	-2.07	BNE
1009210	20.93	21.62	-0.69	BREM	22.72	23.31	-0.59	BREM	33.39	34.71	-1.32	BNE
1009585	20.82	21.24	-0.42	BREM	22.61	22.91	-0.30	BREM	33.39	34.26	-0.87	BNE
1009675	20.77	21.19	-0.42	BREM	22.58	22.87	-0.29	BREM	33.38	34.21	-0.83	BNE
1009820	20.72	21.09	-0.37	BREM	22.53	22.78	-0.24	BREM	33.38	34.08	-0.70	BNE
1010020	20.53	20.64	-0.11	BREM	22.38	22.28	0.11	BREM	33.38	33.45	-0.07	BNE
1010280	20.30	20.46	-0.16	BREM	22.18	22.12	0.06	BREM	33.38	33.47	-0.09	BNE
1010700	19.96	20.05	-0.10	BREM	21.80	21.71	0.09	BREM	33.38	33.45	-0.07	BNE
1010890	19.67	19.75	-0.07	BREM	21.46	21.36	0.10	BREM	33.37	33.44	-0.07	BNE
1011320	19.58	19.70	-0.12	BNE	21.20	21.08	0.12	BREM	33.37	33.43	-0.06	BNE
1011700	19.54	19.64	-0.10	BNE	20.77	20.83	-0.06	BNE	33.37	33.42	-0.05	BNE
1011790	19.53	19.63	-0.10	BNE	20.76	20.82	-0.06	BNE	33.37	33.39	-0.03	BNE
1011810	19.52	19.60	-0.08	BNE	20.73	20.79	-0.06	BNE	33.34	33.38	-0.04	BNE
1012050	19.51	19.59	-0.08	BNE	20.73	20.79	-0.06	BNE	33.34	33.39	-0.05	BNE
1012070	19.50	19.58	-0.08	BNE	20.72	20.77	-0.06	BNE	33.33	33.38	-0.05	BNE
1012200	19.50	19.57	-0.07	BNE	20.72	20.77	-0.05	BNE	33.33	33.38	-0.05	BNE
1012870	19.48	19.56	-0.08	BNE	20.71	20.77	-0.06	BNE	33.33	33.37	-0.05	BNE
1013380	19.48	19.56	-0.08	BNE	20.71	20.77	-0.06	BNE	33.33	33.37	-0.05	BNE

Table A.4 (continued)

Branch	Chainage	2y KBR	2y SKM	2y Diff.	2y Critical	5y KBR	5y SKM	5y Diff.	5y Critical	10y KBR	10y SKM	10y Diff.	10y Critical	20y KBR	20y SKM	20y Diff.	20y Critical
BREM	1013700	6.52	6.31	0.21	BNE	10.07	9.65	0.42	BNE	12.83	12.13	0.70	BNE	15.23	14.80	0.43	BNE
BREM	1014220	6.38	6.20	0.18	BNE	9.95	9.52	0.43	BNE	12.70	12.00	0.70	BNE	15.07	14.65	0.43	BNE
BREM	1014640	6.31	6.15	0.16	BNE	9.87	9.46	0.41	BNE	12.62	11.93	0.69	BNE	14.97	14.57	0.40	BNE
BREM	1015180	6.20	6.06	0.14	BNE	9.75	9.34	0.41	BNE	12.49	11.80	0.69	BNE	14.82	14.45	0.37	BNE
BREM	1015445	6.21	6.03	0.18	BNE	9.77	9.32	0.45	BNE	12.52	11.79	0.73	BNE	14.86	14.46	0.40	BNE
BREM	1015710	6.17	6.01	0.17	BNE	9.74	9.30	0.44	BNE	12.49	11.78	0.71	BNE	14.83	14.45	0.38	BNE
BREM	1016110	6.17	5.96	0.21	BNE	9.73	9.25	0.49	BNE	12.49	11.73	0.75	BNE	14.82	14.41	0.41	BNE
BREM	1016510	6.14	5.93	0.21	BNE	9.68	9.19	0.49	BNE	12.44	11.67	0.77	BNE	14.77	14.36	0.41	BNE
BREM	1017080	6.07	5.87	0.19	BNE	9.60	9.13	0.47	BNE	12.34	11.59	0.74	BNE	14.65	14.27	0.39	BNE
BREM	1017750	5.99	5.82	0.17	BNE	9.53	9.06	0.46	BNE	12.27	11.55	0.72	BNE	14.58	14.24	0.34	BNE
BREM	1018140	5.92	5.76	0.16	BNE	9.46	9.00	0.46	BNE	12.23	11.49	0.74	BNE	14.54	14.18	0.35	BNE
BREM	1018320	5.93	5.74	0.18	BNE	9.46	8.98	0.48	BNE	12.23	11.46	0.76	BNE	14.53	14.16	0.37	BNE
BREM	1018500	5.90	5.74	0.17	BNE	9.43	8.96	0.46	BNE	12.19	11.44	0.75	BNE	14.50	14.14	0.36	BNE
BREM	1018630	5.91	5.72	0.19	BNE	9.44	8.93	0.51	BNE	12.20	11.41	0.79	BNE	14.51	14.13	0.38	BNE
BREM	1018760	5.87	5.69	0.17	BNE	9.39	8.90	0.49	BNE	12.16	11.37	0.79	BNE	14.47	14.10	0.37	BNE
BREM	1019150	5.82	5.67	0.16	BNE	9.37	8.89	0.48	BNE	12.11	11.37	0.74	BNE	14.41	14.09	0.32	BNE
BREM	1019580	5.76	5.61	0.14	BNE	9.29	8.82	0.48	BNE	12.03	11.30	0.73	BNE	14.34	14.04	0.30	BNE
BREM	1020000	5.65	5.53	0.12	BNE	9.14	8.71	0.43	BNE	11.86	11.20	0.66	BNE	14.20	13.96	0.24	BNE
BREM	1020300	5.61	5.42	0.19	BNE	9.09	8.64	0.45	BNE	11.81	11.14	0.67	BNE	14.15	13.92	0.23	BNE
BREM	1020440	5.58	5.38	0.20	BNE	9.08	8.62	0.46	BNE	11.80	11.13	0.67	BNE	14.13	13.91	0.23	BNE
BREM	1020450	5.58	5.38	0.19	BNE	9.07	8.62	0.45	BNE	11.80	11.12	0.67	BNE	14.13	13.91	0.23	BNE
BREM	1020500	5.55	5.37	0.19	BNE	9.07	8.61	0.46	BNE	11.79	11.12	0.68	BNE	14.13	13.90	0.23	BNE
BREM	1020920	5.32	5.17	0.15	BNE	8.92	8.44	0.48	BNE	11.71	11.00	0.71	BNE	14.06	13.84	0.22	BNE
BREM	1021460	5.05	4.93	0.12	BNE	8.56	8.17	0.40	BNE	11.41	10.74	0.67	BNE	13.88	13.69	0.19	BNE
BREM	1022300	4.65	4.55	0.10	BNE	8.05	7.71	0.34	BNE	10.84	10.35	0.50	BNE	13.55	13.54	0.01	BNE
BREM	1022950	4.32	4.27	0.05	BNE	7.63	7.43	0.20	BNE	10.47	10.13	0.34	BNE	13.54	13.54	-0.01	BNE
BREM	1023490	4.07	4.05	0.02	BNE	7.31	7.16	0.15	BNE	10.12	9.88	0.23	BNE	13.54	13.54	-0.01	BNE
BREM	1023510	4.05	3.97	0.08	BNE	7.22	7.04	0.18	BNE	10.09	9.74	0.35	BNE	13.54	13.54	0.00	BNE
BREM	1023870	3.94	3.87	0.07	BNE	7.09	6.91	0.18	BNE	9.84	9.62	0.22	BNE	13.54	13.54	0.00	BNE
BREM	1024220	3.80	3.71	0.09	BNE	6.94	6.71	0.23	BNE	9.68	9.43	0.25	BNE	13.54	13.54	0.00	BNE
BREM	1024520	3.67	3.57	0.10	BNE	6.80	6.54	0.26	BNE	9.57	9.30	0.28	BNE	13.54	13.54	0.00	BNE
BREM	1024750	3.60	3.50	0.10	BNE	6.73	6.45	0.28	BNE	9.50	9.21	0.29	BNE	13.54	13.54	0.00	BNE
BREM	1025300	3.46	3.37	0.10	BNE	6.53	6.25	0.28	BNE	9.34	9.01	0.32	BNE	13.54	13.54	0.00	BNE
BREM	1025670	3.30	3.22	0.08	BNE	6.29	6.05	0.24	BNE	9.14	8.83	0.30	BNE	13.54	13.54	0.00	BNE
BREM	1025920	3.18	3.12	0.06	BNE	6.13	5.91	0.22	BNE	8.97	8.69	0.28	BNE	13.53	13.54	0.00	BNE
BREM	1026150	3.10	3.05	0.05	BNE	6.02	5.81	0.22	BNE	8.83	8.60	0.23	BNE	13.53	13.54	0.00	BNE
BREM	1026560	2.95	2.92	0.03	BNE	5.78	5.59	0.20	BNE	8.48	8.38	0.10	BNE	13.53	13.54	0.00	BNE
BREM	1027100	2.72	2.70	0.02	BNE	5.37	5.25	0.13	BNE	8.15	8.07	0.08	BNE	13.53	13.54	0.00	BNE
BREM	1027640	2.49	2.49	0.00	BNE	4.90	4.91	-0.01	BNE	7.76	7.76	0.00	BNE	13.53	13.54	0.00	BNE
BREM	1027840	2.42	2.42	0.00	BNE	4.75	4.78	-0.02	BNE	7.61	7.63	-0.02	BNE	13.53	13.53	0.00	BNE
BREM	1028190	2.24	2.25	-0.01	BNE	4.43	4.46	-0.03	BNE	7.33	7.35	-0.02	BNE	13.53	13.53	0.00	BNE
BREM	1028490	2.06	2.06	0.00	BNE	4.17	4.17	-0.00	BNE	7.15	7.15	0.00	BNE	13.53	13.53	0.00	BNE

Branch	Chainage	50y KBR	50y SKM	50y Diff.	50y Critical	100y KBR	100y SKM	100y Diff.	100y Critical	200y KBR	200y SKM	200y Diff.	200y Critical	500y KBR	500y SKM	500y Diff.	500y Critical	2000 y KBR	2000 y SKM	2000 y Diff.	2000 y Critical
BREM	1013700	16.93	16.77	0.16	BNE	18.33	18.40	-0.07	BNE	19.48	19.56	-0.08	BNE	20.71	20.76	-0.06	BNE	33.33	33.37	-0.05	BNE
BREM	1014220	16.77	16.65	0.12	BNE	18.30	18.30	-0.01	BNE	19.46	19.55	-0.08	BNE	20.70	20.76	-0.05	BNE	33.32	33.37	-0.04	BNE
BREM	1014640	16.63	16.58	0.05	BNE	18.30	18.30	-0.01	BNE	19.45	19.53	-0.08	BNE	20.69	20.75	-0.05	BNE	33.32	33.36	-0.04	BNE
BREM	1015180	16.49	16.51	-0.01	BNE	18.30	18.30	-0.01	BNE	19.44	19.52	-0.08	BNE	20.69	20.74	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1015445	16.54	16.52	0.02	BNE	18.30	18.30	-0.01	BNE	19.44	19.53	-0.09	BNE	20.69	20.74	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1015710	16.51	16.52	-0.02	BNE	18.30	18.30	-0.01	BNE	19.44	19.53	-0.09	BNE	20.69	20.75	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1016110	16.49	16.50	0.00	BNE	18.30	18.30	-0.01	BNE	19.44	19.53	-0.09	BNE	20.69	20.74	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1016510	16.45	16.47	-0.02	BNE	18.30	18.30	-0.01	BNE	19.44	19.52	-0.08	BNE	20.69	20.74	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1017080	16.37	16.42	-0.05	BNE	18.30	18.30	-0.01	BNE	19.43	19.51	-0.08	BNE	20.68	20.74	-0.05	BNE	33.31	33.36	-0.04	BNE
BREM	1017750	16.32	16.41	-0.09	BNE	18.29	18.30	-0.01	BNE	19.43	19.51	-0.09	BNE	20.68	20.74	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1018140	16.29	16.37	-0.09	BNE	18.29	18.30	-0.01	BNE	19.43	19.51	-0.08	BNE	20.68	20.74	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1018320	16.28	16.37	-0.08	BNE	18.29	18.30	-0.01	BNE	19.43	19.51	-0.08	BNE	20.68	20.74	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1018500	16.26	16.36	-0.09	BNE	18.29	18.30	-0.01	BNE	19.43	19.51	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1018630	16.27	16.36	-0.09	BNE	18.29	18.30	-0.01	BNE	19.42	19.51	-0.08	BNE	20.68	20.74	-0.06	BNE	33.32	33.36	-0.04	BNE
BREM	1018760	16.26	16.35	-0.10	BNE	18.29	18.30	-0.01	BNE	19.43	19.51	-0.08	BNE	20.68	20.74	-0.06	BNE	33.32	33.36	-0.05	BNE
BREM	1019150	16.23	16.35	-0.12	BNE	18.29	18.30	-0.01	BNE	19.42	19.51	-0.08	BNE	20.68	20.74	-0.06	BNE	33.32	33.36	-0.05	BNE
BREM	1019580	16.23	16.33	-0.10	BNE	18.29	18.30	-0.01	BNE	19.42	19.51	-0.08	BNE	20.68	20.73	-0.06	BNE	33.32	33.36	-0.05	BNE
BREM	1020000	16.23	16.30	-0.07	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.05	BNE
BREM	1020300	16.23	16.28	-0.05	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1020440	16.23	16.27	-0.05	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1020450	16.23	16.27	-0.05	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1020500	16.23	16.27	-0.04	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.06	BNE	33.31	33.36	-0.04	BNE
BREM	1020920	16.22	16.25	-0.02	BNE	18.29	18.30	-0.01	BNE	19.42	19.50	-0.08	BNE	20.68	20.73	-0.05	BNE	33.31	33.36	-0.04	BNE
BREM	1021460	16.23	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.41	19.49	-0.08	BNE	20.67	20.73	-0.05	BNE	33.31	33.36	-0.04	BNE
BREM	1022300	16.23	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.41	19.49	-0.07	BNE	20.67	20.72	-0.05	BNE	33.31	33.35	-0.04	BNE
BREM	1022950	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.41	19.48	-0.07	BNE	20.67	20.72	-0.05	BNE	33.31	33.35	-0.04	BNE
BREM	1023490	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.41	19.47	-0.06	BNE	20.67	20.72	-0.04	BNE	33.31	33.34	-0.03	BNE
BREM	1023510	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.40	19.46	-0.06	BNE	20.66	20.71	-0.04	BNE	33.30	33.33	-0.03	BNE
BREM	1023870	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.40	19.46	-0.06	BNE	20.66	20.71	-0.04	BNE	33.30	33.34	-0.04	BNE
BREM	1024220	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.39	19.45	-0.06	BNE	20.66	20.70	-0.04	BNE	33.30	33.34	-0.04	BNE
BREM	1024520	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.39	19.45	-0.06	BNE	20.66	20.70	-0.04	BNE	33.30	33.34	-0.04	BNE
BREM	1024750	16.22	16.23	-0.01	BNE	18.29	18.30	0.00	BNE	19.39	19.44	-0.05	BNE	20.66	20.70	-0.04	BNE	33.29	33.33	-0.04	BNE
BREM	1025300	16.22	16.23	-0.01	BNE	18.29	18.30	0.00	BNE	19.39	19.43	-0.05	BNE	20.66	20.69	-0.03	BNE	33.29	33.32	-0.03	BNE
BREM	1025670	16.22	16.23	0.00	BNE	18.29	18.30	0.00	BNE	19.38	19.43	-0.04	BNE	20.66	20.69	-0.03	BNE	33.29	33.32	-0.03	BNE
BREM	1025920	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.38	19.42	-0.04	BNE	20.65	20.68	-0.03	BNE	33.29	33.31	-0.02	BNE
BREM	1026150	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.38	19.42	-0.04	BNE	20.65	20.68	-0.03	BNE	33.29	33.31	-0.02	BNE
BREM	1026560	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.38	19.41	-0.04	BNE	20.65	20.68	-0.02	BNE	33.29	33.31	-0.02	BNE
BREM	1027100	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.38	19.40	-0.03	BNE	20.65	20.67	-0.02	BNE	33.29	33.30	-0.01	BNE
BREM	1027640	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.37	19.39	-0.02	BNE	20.65	20.67	-0.02	BNE	33.29	33.29	-0.01	BNE
BREM	1027840	16.22	16.23	0.00	BNE	18.29	18.30	-0.01	BNE	19.37	19.39	-0.02	BNE	20.65	20.66	-0.02	BNE	33.29	33.29	0.00	BNE
BREM	1028190	16.22	16.23	-0.01	BNE	18.29	18.30	-0.01	BNE	19.37	19.38	-0.02	BNE	20.65	20.66	-0.01	BNE	33.28	33.29	0.00	BNE
BREM	1028490	16.22	16.22	0.00	BNE	18.29	18.29	0.00	BNE	19.36	19.36	0.00	BNE	20.64	20.64	0.00	BNE	33.28	33.28	0.00	BNE